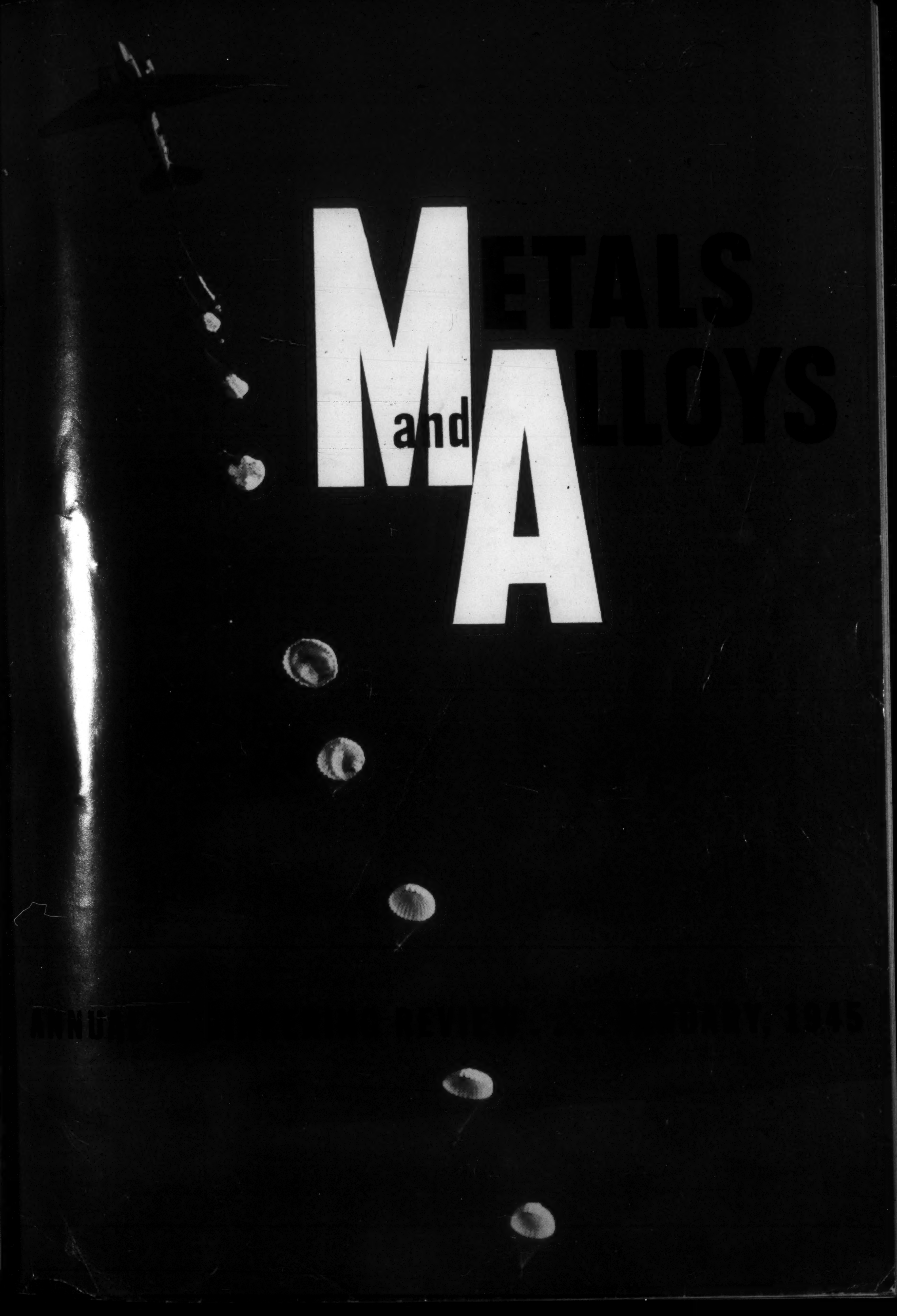
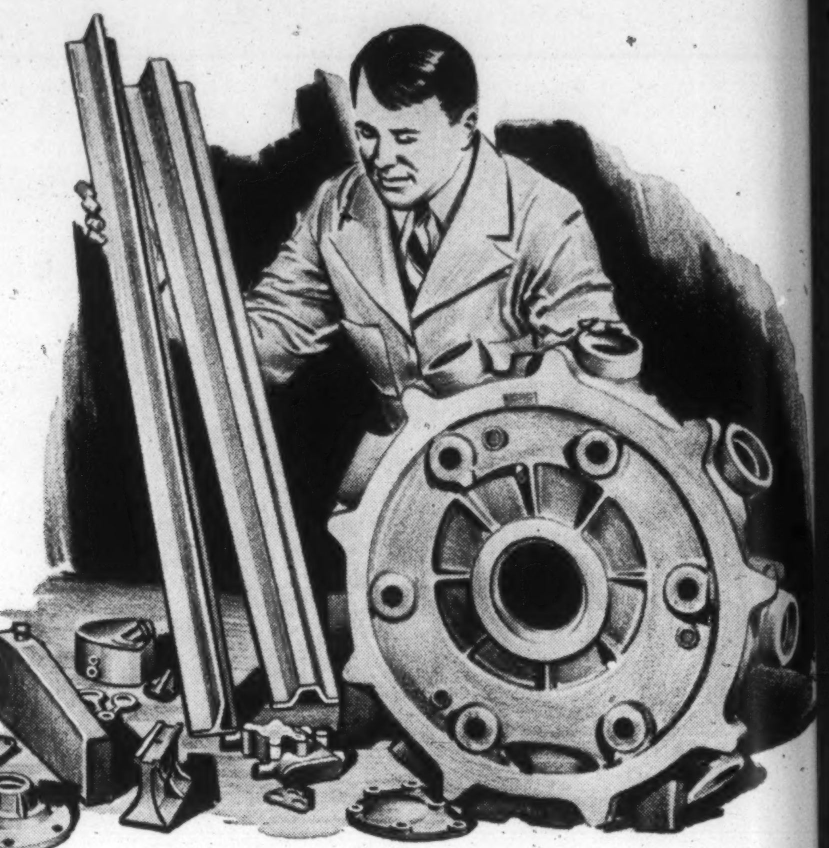


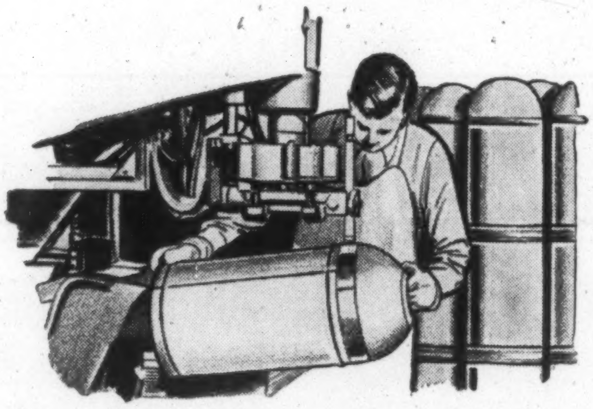
METALS and ALLOYS

ANNUAL [illegible] REVIEW [illegible] JANUARY, 1945

Magnesium alloys
are fabricated and joined
by all common methods



and Dow's complete fabrication plants
are always ready
to work with you



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The fruits of more than a quarter-century of Dow engineering and fabrication experience are ready at hand to translate your ideas into new, weight-saving products of Dowmetal—*the metal of motion*. For in Dow's own shops—and in numerous other plants as well—Dowmetal Magnesium Alloys, with their high strength-weight ratio, show full versatility in sand, permanent mold and die casting; sheet, plate and strip rolling; rod, bar, tube and special shape extrusion; press and hammer forging—and bendin drawing, pressing, spinning, blanking, punching a shearing.

Likewise Dowmetal is readily joined by all usual proc dures—riveting and arc, spot, gas and flash welding.

There is no mystery to magnesium processing techniqu These lightweight alloys call for procedures very similar those employed with other metals.

Skilled technical advisers await your call at the neare Dow office, to help work out the best way to use Do metal in your own product.

DOWMETAL *magnesium*

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METALS and ALLOYS

The Engineering Magazine of the Metal-Working Industries

VOLUME 21 • NUMBER 1 • JANUARY, 1945

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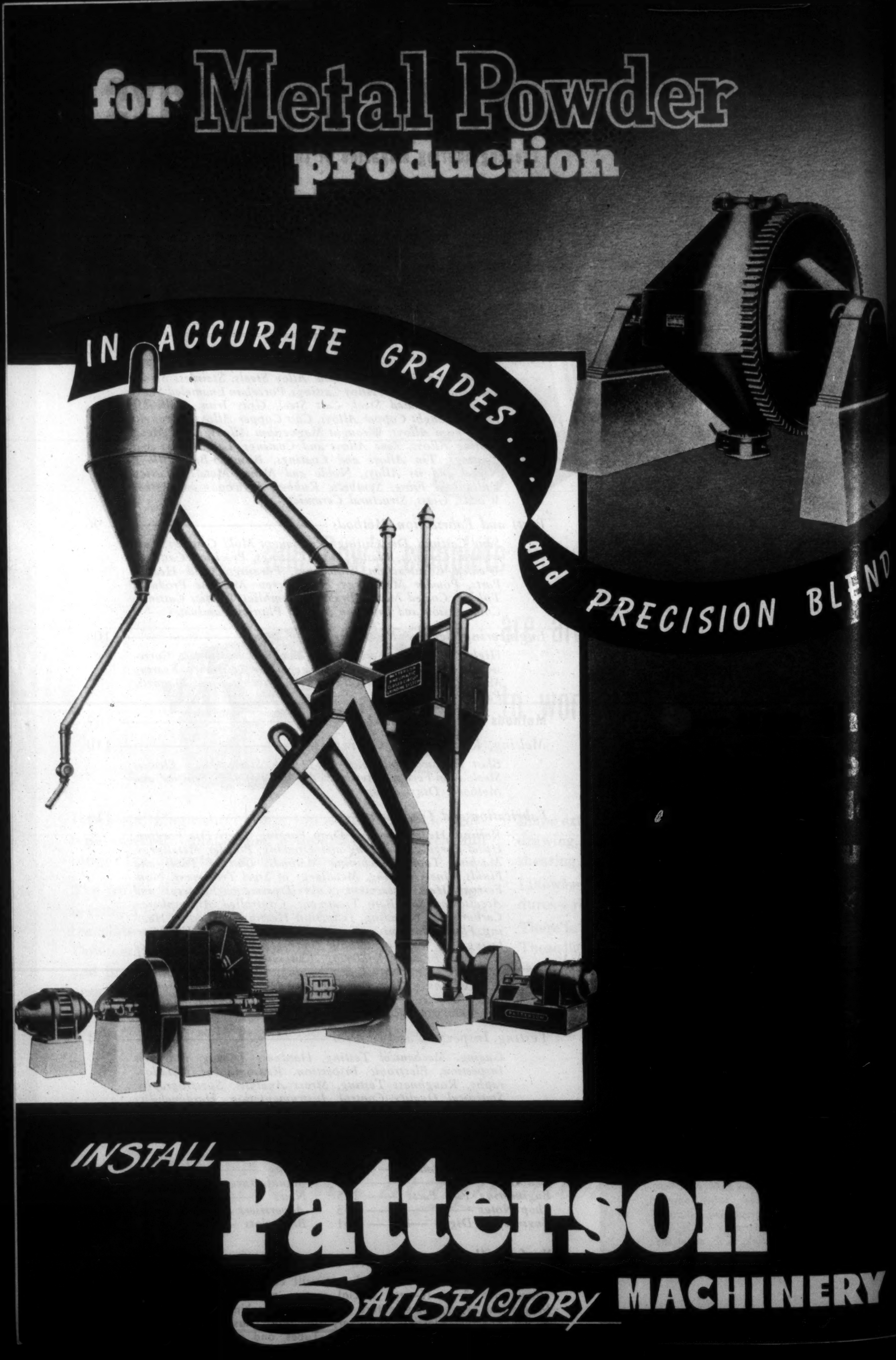
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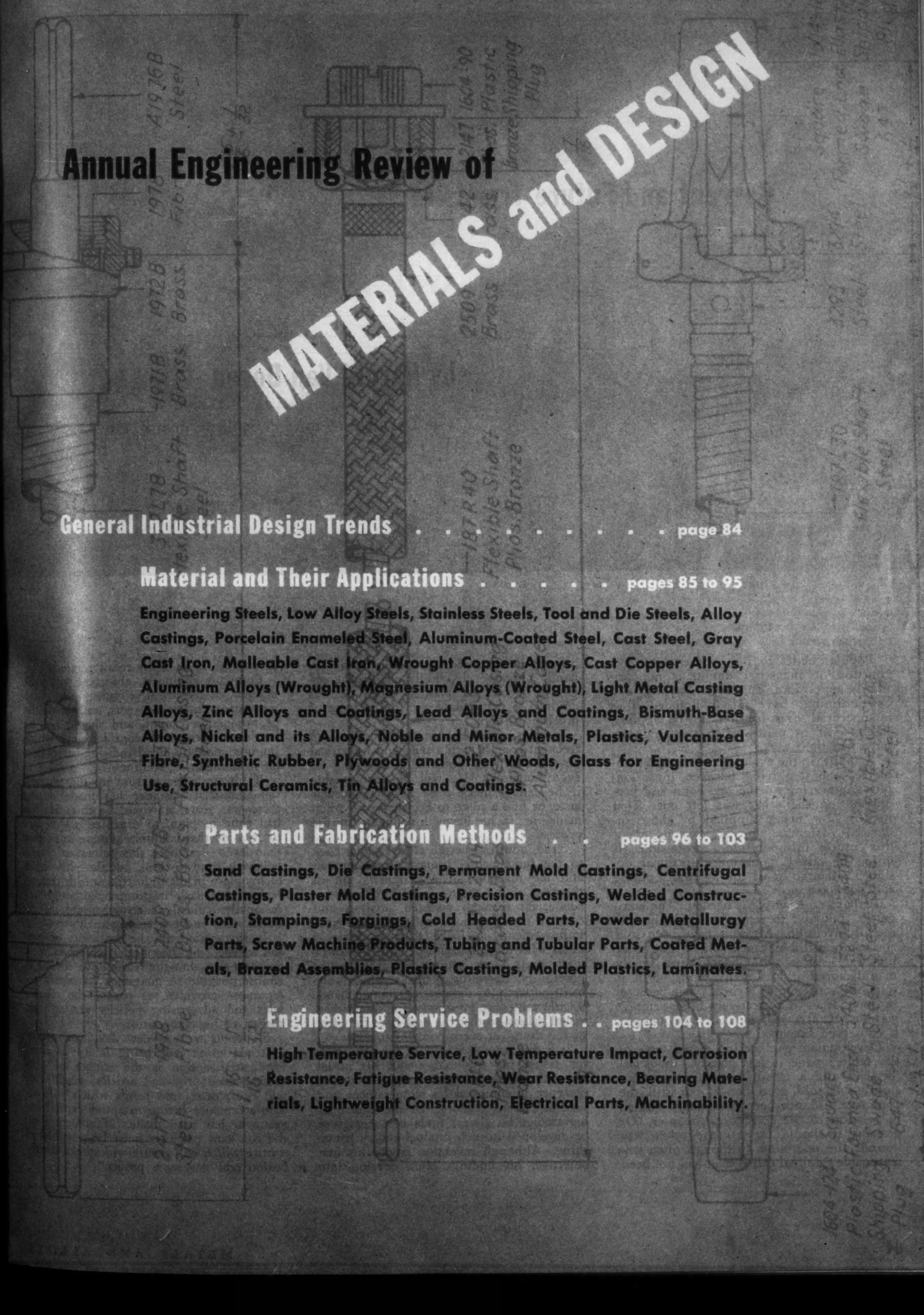

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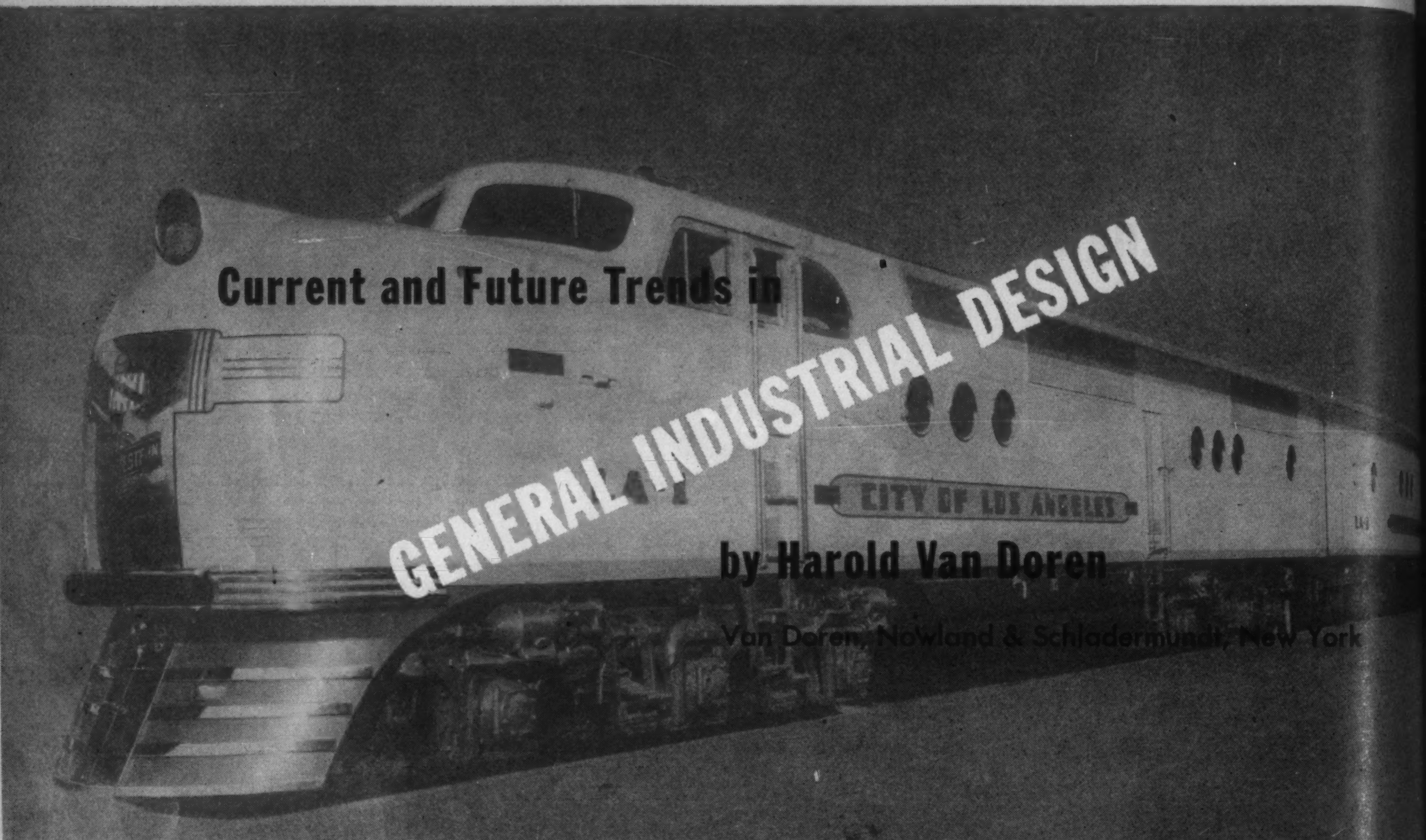


Current and Future Trends in GENERAL INDUSTRIAL DESIGN

by Harold Van Doren

Van Doren, Nowland & Schladermundt, New York

Popular belief to the contrary, the true function of industrial design is not primarily appearance. The words "styling" and "streamlining" have falsely branded it as a superficial dress-up job, to be applied, like a coat of paint, when the engineers have had their say.

Actually, in the evolution of modern commerce, one step lying between invention-plus-engineering on the one hand and production on the other was left out. That step is now being supplied by those industrial designers who are serious about this much misunderstood profession. It might be called "consumer functional design," although it is an awkward phrase and not too exact.

Perhaps an example is needed. The automatic "pop-up" toaster was a highly successful invention. Millions have been sold and many millions more will be sold after the war. As first engineered and finally manufactured it had many faults. Still it sold like soda pop at a county fair because, in spite of its comparatively high price, it was *useful*. It saved steps, it saved temper, it conserved bread.

Development engineering erased some of the faults, made it less cranky. Industrial "stylists" did a face-lifting, made it more sightly. It sold even better; but still the appliance had not been completely studied in relation to the consumer, the *user*. Or perhaps it should be put the other way 'round: the reasoning (although often unreasonable) animal called man had not been objectively measured in relation to the dynamic (because electrically energized) object of metal and plastics which he was destined to manipulate with the purpose of processing a food.

Here is a sentient animal brought into frequent contact with a mechanico-electrical device which is potentially annoying or even dangerous. He will be unreasonable if he cannot make toast to *his* particular taste, or find a place to keep it warm when made, or if he burns his fingers in the process.

True industrial design always comes back to the fundamental contact of the human and the machine. The designer's job in the case of the toaster is to ferret out inadequacies through research, analysis and creative interpretation, to develop the final improvements to make toast to variable tastes with the minimum of effort: built-in toast racks, easy crumb removal, better portability, operating controls which conform perfectly to the average human hand. Tactile values are even more important than visual values, so that the user likes the "feel of the thing" at every point of contact.

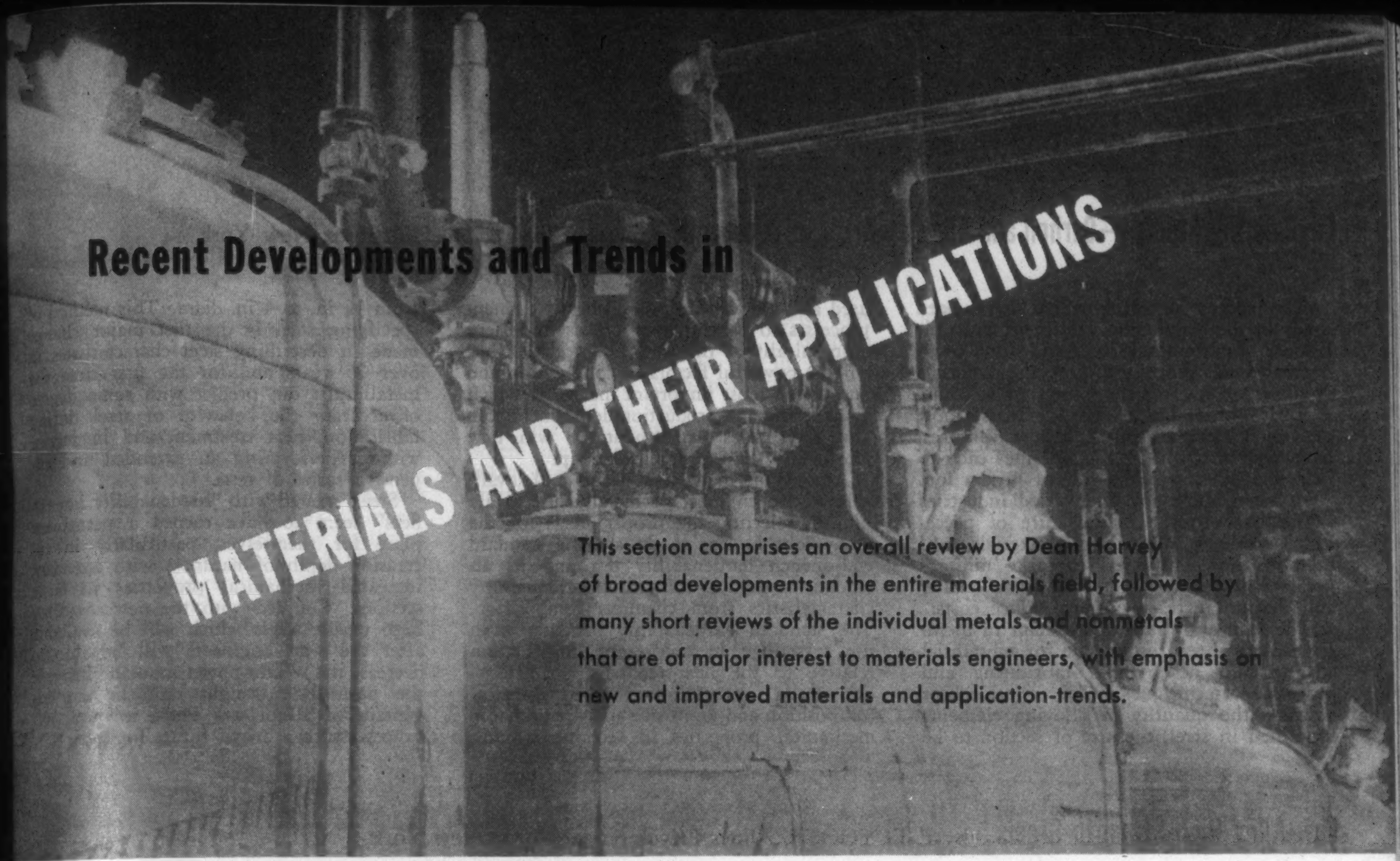
It is this *terra incognita* of the consumer, his tastes, his psychology and his actual physical make-up that the sound industrial designer is equipped by temperament and predilection to explore. In the course of his studies he always finds new angles to be developed in each product and each machine. Although invention is not his first objective, his findings often develop into inventions, or radically recast products.

Company engineers, absorbed with vital matters of electrical circuits, mechanical movements, materials, costs, and the details of production cannot, and should not, be burdened with these considerations which impinge more on merchandising values than on manufacturing routine.

If I were asked to sum up the progress the industrial designer has made during these war years, it would be this: He has had time to plan, to organize, to prepare to do a job that is infinitely more important than even designers themselves originally believed; time to think out the philosophy of his place in the industrial world; time to realize that flash inspiration, although occasionally fruitful, is no substitute for rational study and penetrating analysis.

In this period too the technique of consumer checking has been developed to a degree never thought feasible, so that it is almost possible to guarantee consumer acceptance—provided, of course, the client's sales and advertising policies are at least abreast of his competition.

So let us write a new definition of industrial design and bring it up to date. "Industrial design is the science of precasting mass produced articles, machinery, and equipment, into forms which will assure acceptance before extensive capital investment has been made. Manufacture of the resultant products must be possible at a price which will insure widespread distribution and guarantee profits."



Recent Developments and Trends in MATERIALS AND THEIR APPLICATIONS

This section comprises an overall review by Dean Harvey of broad developments in the entire materials field, followed by many short reviews of the individual metals and nonmetals that are of major interest to materials engineers, with emphasis on new and improved materials and application-trends.

Materials Engineering Today

by DEAN HARVEY, Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

Never before in history has there been such rapid development in materials and in their application as has occurred during the past five years. We now appreciate more fully how much we have been depending upon some of the commonly used materials such as tin and rubber, which recently have been curtailed, or replaced by other materials.

Manufacturers of equipment realize that in order to maintain their position in the highly competitive markets after the war, they will have to take advantage of the developments in materials in the design of equipment.

Various substitutes for scarce materials, which have given as good performance as the original material, or have proved to be even superior, will be retained. They illustrate what can be done by a careful study of the application. More effective use of materials can thus be obtained both from the standpoint of cost and of performance by making similar studies. In this way, many persons are becoming acquainted with the merits of types of material which are new to them, and are applying them to widely different applications.

The war has been enormously stimulating to the development of many new and valuable classes of materials. For instance, under the pressure of necessity, a great variety of plastics products has been produced almost overnight. Under these circumstances, there is a tendency to use these new materials on account of their desirable properties, without giving sufficient consideration to their limitations. In the application of a new material, all of its properties which have a bearing upon its proposed use should be reviewed to make certain that it does not have undesirable properties which would interfere with its successful use.

The development of a new class of materials frequently brings forth the claim that it will replace others already in use—for instance, that plastics will replace steel. The large family of new plastics should provide the basis for many new applications. The two fields of application of plastics and steel respectively, overlap to some extent, but do not coincide, as their properties are not the same. As a rule, a new material finds its own field of application for which it is particularly suited, and on account of its desirable properties allows entirely new applications to be made.

The new materials now withheld from general use as confidential for military applications, include a number of developments that will be of great value to industry when they have been released.

Government contracts have brought to the attention of thousands of companies the use of specifications for the purchase of materials. The specification states the required properties for the material, and how they are to be determined, by agreement between the manufacturer and the purchaser. This is bound to result in a wider use of purchase specifications in industry. Valuable assistance in promoting the use of sound specifications which are commercial, and avoiding excessive requirements, is being given by the American Society for Testing Materials whose field is the preparation of specifications and methods of test for materials. Other Societies can assist also in their respective fields.

A few of the more notable developments in materials may be mentioned, which should have considerable influence upon design.

The National Emergency Steel program, conceived to increase the output of the steel mills for the war needs with existing equipment, has accomplished this purpose by a large reduction in the number of kinds of steel produced. It is to be hoped that much of this simplification program will be retained on account of its obvious benefits.

In the conservation program for nickel, chromium and other alloying elements for steel, it has been found that a combination of several of these elements in smaller proportions produces alloy steels which are quite adequate for many applications.

The synthetic rubber compounds, whose development in such a short time has been called the most outstanding accomplishment of our time, already have given a good account of themselves. They have a field of their own which overlaps but does not coincide with natural rubber.

The new light alloys of aluminum or magnesium provide lightness, strength, and other properties needed in the transportation field and other places for moving parts.

Similar progress has been made in many classes of materials, and the wise materials engineers and designers are keeping abreast of the times by informing themselves of the developments along the lines of most value to them.

Engineering Steels—Carbon and Alloy

by C. M. PARKER, American Iron & Steel Institute, New York

The recent advances which have been made in the production, treatment and utilization of wrought carbon and alloy engineering steels promise to keep the materials engineer on his toes for some time to come. A series of technical developments, most of which started as independent ventures, have now met on production lines each to help the other win the war of production. And when our many and varied industries swing back to the manufacture of peacetime products the newer materials and methods now employed to make military goods will be available to improve quality and design, increase output, reduce costs.

The lean alloy steels, important in themselves, have been responsible for substantial advances in design and fabricating and processing techniques. The relationships between the quantity of alloying elements contained in steel, the size of section to be used and the fabricating and heat treatment processes to be employed are as important economically as they are technically. They will be powerful factors in competition and one of the most important means by which engineering and production departments can arm their sales departments to win new glories in their race for leadership.

Among the many new useful tools available to the engineer or metallurgist to aid him in selecting the proper steels for the many jobs he has to do are the standard end-quench hardenability test and its attendant method of computing hardenability characteristics from chemical composition. The standard hardenability bands now in use crystallize in one graph information relative to the heat-treatment characteristics of the steel as influenced by chemical composition and grain size and the probable mechanical properties in sections ranging from ¼ in. to 4 in. diam. This method of specifying steel is the first major change made in describing steel characteristics in over 25 years and for the first time the metallurgist can predict with some degree of accuracy the behavior of steel during fabrication, heat treatment and in service without performing an extended and expensive series of tests.

Steels treated with "hardenability intensifiers" seem to have earned a permanent place for themselves, particularly in increasing depth of hardness with attendant increased mechanical properties in large sections. Coupled with the new low-alloy high tensile steels which will be available after the war, engineers will be able to decrease the weight-power ratio and increase the payload-deadweight ratio to the advantage of all of us. These technical advances assure a bright future for steel.

Low-Alloy High-Strength Steels

by F. D. FOOTE, Alloys Development Corp., New York

Great strides were made with the low-alloy high-strength steels in the transportation field prior to the imposition of war restrictions upon the civilian use of the strategic alloying elements required in their manufacture. During the five years 1935 to 1939 inclusive, a period commencing just one year after these new steels were introduced, the superstructures of 35,027 of a total of 152,108 new freight cars installed by Class I railroads were built wholly or in part of one of the leading steels of this group. This comprised 23% of the new equipment installed, and the cars were distributed over twenty-four Class I railroads. Over this same period, with 1940 added, 7,117 new light-weight cars of various types were installed on eighteen Class II and III railroads, private lines and on foreign lines.

Even greater progress was made with these steels over this period in the construction of railroad passenger cars. The October 14, 1939 "Passenger Progress Issue" of *Railway Age* lists 1,458 units delivered, of which 63% were of low-alloy high-strength steel, 20% of stainless, 11% aluminum and only 6% of conventional design using ordinary carbon steel.

Considering that seven years are normally required to introduce a new development in the steel and railroad industries, the accomplishments described augur well for the light-weight movement in this field in post-war days.

Similar strides have been made with the mild alloy steels in the construction of street cars and buses, trucks and trailers, mine cars, dump cars, road building equipment, locks and gates for river dams, etc. They were also employed in a number of oil tankers, barges, and ships of various sizes. Their resistance to corrosion from sea water and petroleum products and to mechanical damage in this service was marked, and their use in peace time is assured.

Weight saving, in order to provide more efficient structures which can be operated on a lower cost basis, is usually the chief objective. Savings where low-alloy high-strength steels displace ordinary structural steel amount to about 22 to 24% and in most instances the modern designs can be made at little or no increase in initial cost.

It is anticipated that when fabricators have become thoroughly familiar with these steels, and have properly equipped for their use, the lighter designs will be produced at costs lower than those required for the conventional designs of the past.

Stainless Steels and Irons

by G. K. HERZOG, Electro Metallurgical Co., New York

Although the outstanding recent developments in the stainless steel field are still military secrets, it is possible to indicate broadly what directions these are taking. Stainless irons and steels were increasingly applied for heat resistance or mechanical property reasons. The so-called "free-machining" stainless steels received wider use and improved materials and techniques for forging and stamping these steels were evolved.

Development of jet propulsion equipment for aircraft and of the gas turbine as a prime mover for a wide variety of applications has stimulated the development of alloys with properties not heretofore available for high temperature uses. The efficiency of a gas turbine operating with inlet gas at 1025 F is only 16% but increases to 22% with inlet gas at 1200 F so that the great importance of alloys suitable for continuous operation at temperatures higher than are now possible is at once apparent.

The alloys suitable for application at high temperatures heretofore available were frequently incapable of being fabricated by forging or machining, and had to be cast to the final finished shape and size. Much work has been done on the development of alloys with superior creep strength and stress-rupture values at high temperatures, especially those which possess a certain degree of forgeability and machinability, but the results achieved cannot as yet be told.

Experience during the year has confirmed the fact that the composition of the heat and corrosion resistant steels adopted prior to the war were based on sound developments. While steels of modified composition have been used and are still being used with success, there is a tendency to go back to the old "stand-bys" when these are available. The increasingly familiar "16 and 2" composition is establishing itself as an important wartime member of this group of materials, although its ultimate position with respect to 18 and 8 is not clear.

Chromium is still by far the most important element for imparting heat and corrosion resistance to these steels. Nickel is quite generally used in the production of the austenitic type of stainless steel, although manganese has been used at times to replace all or part of the nickel, especially where resistance to heat was the primary requirement. Nickel, however, is still preferred where resistance to chemical corrosion is concerned.

Manganese is more frequently used as a supplement to, rather than a replacement of, nickel because of the improved hot-working and welding characteristics it imparts to the austenitic steels. The use of addition elements like molybdenum, tungsten, silicon, selenium, bismuth, titanium and columbium to impart special characteristics has continued to develop.

Electropolished and blackened stainless steels are surface-treated types currently receiving considerable attention.

Tool and Die Steels

by S. C. SPALDING, American Brass Co., Waterbury, Conn.

Early in the war program, to help ease the demand on scarce or potentially scarce elements, Government restrictions issued through the War Production Board were put on their use in tool steels. The elements principally affected were tungsten and vanadium. The result was to remove a number of well known types of tool steels from the market entirely and to definitely modify the composition and properties of others.

The year 1944 was marked by the lifting of these restrictions, which took place on January 21st. The result was an immediate swing back to prewar metallurgy for tool steel compositions. The tungsten high-speed steel which, under duress of Government order had been almost entirely replaced by molybdenum types, came rapidly back into popular favor until in a few months the molybdenum high-speed steels were again in the minority position. Vanadium also rapidly resumed its use in normal quantities in the high-speed carbon and alloy tool and die steels.

In the molybdenum high-speed steels where the tungsten-molybdenum type remains the most popular, the trend in this steel has been toward higher tungsten, molybdenum, and vanadium percentages. From the 5% W, 4 Mo, 1.5 V combination it has crept up to 6.5% W, 5.5 Mo, 2 V. This steel seems better adapted to the present overburdened scrap market and has improved cutting properties over the leaner type.

On the removal of the restrictions on the use of vanadium in the tool and die steels, its use immediately rose to more generous proportions in the high-speed steels where it had been held to the absolute minimum limits, and the special high vanadium types of super high-speed steels came back into the picture.

The standard carbon vanadium tool steel which had been greatly missed during the restricted period was immediately restored, with normal vanadium content, and vanadium generally was put back in the hot work and general alloy tool and die steels where its absence had been definitely felt under the necessary restriction orders of alloy scarcity.

The year 1944, therefore, must be considered as a return from restrictive conditions to normalcy, which, without doubt, must be the first step toward further progress and the forerunner in the development of the tool steel of the future.

Alloy Castings for Heat and Corrosion Resistance

by F. B. FOLEY, The Midvale Co., Philadelphia, Pa.

The chemistry of high alloy heat and corrosion resistant castings came in for a certain amount of revision because of shortages in alloying material brought about by the war's unprecedented demands and the efforts of the War Production Board to make the available supply do the most good in the war effort. On the other hand, war conditions promoted the development of modifications in chemistry and dictated the use of high alloy castings under service conditions not heretofore attempted. Notable among the advances accomplished as a war necessity was the extension of the use of ferrous heat resistant castings of rather conventional compositions to temperatures as high as 2150 to 2200 F. The use of ferrous materials at such high temperatures would not have been recommended a few years ago and yet these alloys have been in service in the form of magnesium retorts in practically continuous service in some cases for over 500 days. This undertaking led, in some foundries, to an expansion of centrifugal casting facilities.

The increased service requirements of metals in such applications as rotors and buckets for superchargers and gas-turbines has led to the development of new alloys for use in cast form. In the development of alloys requiring a high order of resistance to deformation at high temperatures it is natural that a point is reached where deformation of such alloys by hot forming, either by rolling or forging, becomes difficult and sometimes so wasteful as to be wholly uneconomical, if not impossible.

The centuries-old art of casting by the lost wax process used extensively in recent years by the dental profession in making precision investment castings has been brought into the production of supercharger buckets and small stainless steel parts. Pressure, developed by centrifuging, and other modern refinements have been added to attain freedom from casting defects while preserving the very desirable precision of dimensions. Stainless steel castings made by this process and finally electrolytically polished have the appearance of jewelry.

A review of the work of almost any industry during recent years would hardly be complete without citing as an important development the strong trend towards technical cooperation within the various branches of industry. Much of this has come about informally through a mutual interest in the production of war materials and has been, to a great extent, sponsored by governmental organizations. Technical advances in the alloy casting industry continue to be made largely as the result of cooperative research. The war period has shown how all industries benefit by such cooperation. The success of the Alloy Casting Institute is making it a model for similar organizations in other branches of industry.

Porcelain Enameled Steel

by EDWARD MACKASEK, Porcelain Enamel Institute, Inc., Washington, D. C.

Porcelain enamel can be most simply described as a combination of metal and glass inseparately bonded together by a high-heat fusing operation. This glass-like, inorganic finish may be used to provide the almost unlimited decorative possibilities inherent in its vast range of colors, or it may be utilized solely because of the permanent protection it affords to the metal base. Modern porcelain enamel is developed specifically to meet the requirements for special services. It is made to resist acids, hard abrasive wear, surface scratching, high temperatures, thermal shock, electrical conductivity, and atmospheric agents.

Up to now, it has been necessary to apply a dark blue-black cobalt coat to the steel as a primary coat because the white or light colored cover coats could not be made to bond directly to the steel base. A new enamel for direct application has been announced. Success in this effort, however, is not due entirely to the development of an enamel having the required properties that will bond it direct to the steel in the fusing operation. Research on the part of the steel companies has disclosed a new composition of iron for enameling purposes that provides the ideal backing for this new enamel.

The introduction of this improved porcelain enamel will have far-reaching effects on the entire industry. The elimination of the ground coat will do more than merely provide a saving that will come from a reduction in the use of material and reducing the number of processing operations required. By permitting the product to be finished with a much thinner enamel application, it will increase the resistance to impact and reduce the hazard of chipping. The new steel also gives promise of less distortion at the high furnace heat, and porcelain enameled ware made from it will show less effect of warpage.

A vast new field of application for porcelain enamel has been opened up as a result of a new type of high temperature of enamel that has been developed at the National Bureau of Standards for naval and military use. This enamel is capable of withstanding not only the high temperatures of exhaust manifolds in airplanes, but the tremendous thermal shock that may be encountered under actual service conditions. It can be heated to red heat and plunged into cold water without shattering, and tests have shown that it will withstand repeated alternations of this kind better than stainless steel. Another interesting property of this coating is that it can be applied exceedingly thin. A single coat has a thickness of only 0.002 in.

Aluminum-Coated Steel

by ANSON HAYES, The American Rolling Mill Co., Middletown, Ohio

A flat-rolled product of considerable post-war interest is hot-dipped aluminum-coated sheet and strip steel. It combines the surface characteristics of aluminum with various physical properties obtained from steel. Good corrosion resistance, heat resistance, and attractive appearance are achieved.

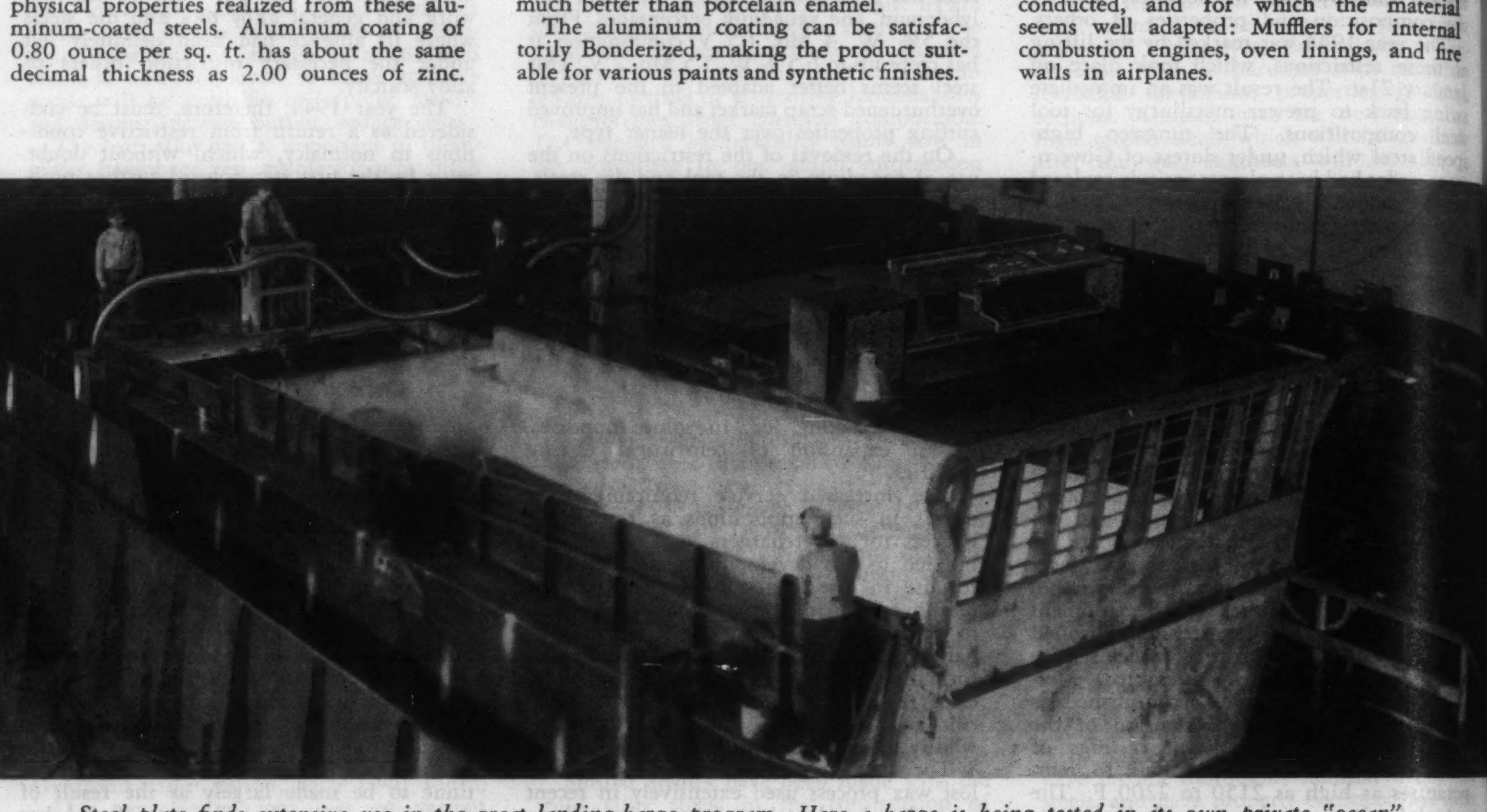
Low carbon steels and high-strength steels make satisfactory base metals for this coating. Thus there exists a wide range of physical properties realized from these aluminum-coated steels. Aluminum coating of 0.80 ounce per sq. ft. has about the same decimal thickness as 2.00 ounces of zinc.

Tests on corrosion resistance under atmospheric conditions indicate a coating life of at least six times that of zinc coatings of equal weight. Tests in 20% salt spray at 95 deg. F. reveal a coating life of more than 500 hours. When the coated surface is buffed the product has a heat reflectivity of 75 to 85% in the temperature range of 600 to 1000 deg. F. This is slightly better than #7 finish 18-8 stainless steel and much better than porcelain enamel.

The aluminum coating can be satisfactorily Bonderized, making the product suitable for various paints and synthetic finishes.

Based on these qualities and characteristics it is evident that aluminum-coated steel is well suited to a wide variety of uses where the corrosion- and heat-resistance, reflectivity or appearance of aluminum is desired. This is especially true where combinations of corrosion- and heat-resistance must be met.

These are a few applications on which extensive service tests have already been conducted, and for which the material seems well adapted: Mufflers for internal combustion engines, oven linings, and fire walls in airplanes.



Steel plate finds extensive use in the great landing-barge program. Here a barge is being tested in its own private "ocean"

Gray Cast Iron

by C. H. LORIG, Battelle Memorial Institute, Columbus, O.

The "materials engineering" progress in gray iron during the past year has resulted from a further application of what is known of the relation of foundry practice and iron composition to metal quality. Improvements in foundry practice and results of research have been responsible for steady improvement in the properties of gray iron and in its suitability for severe service applications.

The application of gray iron for many wartime needs, where its use had not been apparent at the beginning of the war program, is most significant and reflects the progress made by industry in gaining acceptance for gray iron in the war effort. An outstanding instance is the full recognition that gray iron can serve for heat-resistant applications up to temperatures once thought 'way beyond its range. Continuing progress, too, has been shown in the use of high-strength irons for parts once "necessarily" made of forged or cast steel and in growing appreciation of the damping capacity and structural rigidity of cast iron as an engineering material for heavy-duty use.

It is no longer uncommon to use radiographic procedures in the solution of gating and heading problems. Such procedures, together with other control methods for improving the product, have contributed to the production of sounder, more uniform, and more dependable gray iron castings that consistently meet required specifications. Rejections from normal foundry casting defects have consequently been minimized.

Welding of cast iron was formerly highly restricted in its application but is now accepted as an important process for extending the field for gray iron castings. An SAE subcommittee which undertook to formulate specifications for the welding of gray iron has achieved notable progress.

A continued growth in the practice of inoculating to achieve greater uniformity in structure and in the properties of gray iron is apparent. In a few cases, inoculants are being employed in minute quantities to increase the hardness and to improve the character of chilled surfaces on castings.

The principal trend in compositional changes for improved properties has been toward moderately high-carbon irons suitably balanced in silicon and alloy contents to obtain high strength while retaining the excellent castability features characteristic of the higher carbon irons. Such irons are suited to regular cupola melting and are economical to produce, since they offer no major problem in the foundry from unsoundness and do not have many of the shortcomings of the low-carbon irons.

The application of centrifugal and centrifuging methods in the production of gray iron castings is being stimulated by the growing interest in the use of these methods for the casting of all types of metals. Diesel engine sleeves and piston rings cast centrifugally are showing outstanding performance records. Such methods of casting are being adapted to gray iron production as rapidly as the need develops and facilities become available.

Cast Steel by C. W. BRIGGS, Steel Founders' Society of America, Cleveland

Exceedingly large tonnage of cast steel is still going into the machines of War. It has been possible during the year to present details on the production of certain ordnance castings, such as the very important and highly stressed breech ring castings for guns that have been produced as replacements for forgings. Further developments have been made in armor castings such as turrets and hulls for tanks. Information on the cast armor plant has also been presented, to illustrate the developments in casting equipment and the key to recent armor casting production.

The huge earthquake type bombs as used by the British are being produced as steel castings. The wall sections and openings on these are being made to close tolerances.

Further progress has been made in the adoption of light section, high strength steel castings for the aircraft industry. Both centrifugal and static steel castings are being used. An increasing number of steel foundries have become equipped to produce centrifugal castings.

Three steel foundries are now equipped to produce, by the investment molding process (lost wax process) small steel castings to very close tolerances.

On the basis of a research investigation by the Steel Founders' Society on certain carbon and alloy cast steels, it has been shown that time-temperature transformation curves for cast steel are similar in shape and position to those for wrought steels of similar compositions. This means that all the S-curves developed for wrought steels can be utilized in the heat treatment of steel castings.

The water quenching of steel castings has been extended during the year to additional casting types. Information on the technique of water quenching, using time-quench methods, and production equipment as employed at various foundries has been extensively reported during the year. Considerable information on the compositions and casting sections to quench-out the varying sections in commercial castings is being developed.

Research on the hardenability of cast steel has shown that the end-quench hardenability curves, for carbon and a number of alloy cast steels studied, compare favorably with the hardenability curves for wrought steels of similar compositions. Hardenability curves have been developed for carbon cast steels, a number of the SAE steels as cast steels and for the NE steels produced as cast steels.

The steel casting industry has continued with the production of certain of the NE steels, and is investigating others. The properties of commercially produced NE cast steel were investigated throughout the year.

Malleable Cast Iron by J. H. LANSING, Malleable Founders' Society, Cleveland

The increased demand for malleable iron castings in 1944 has made the Industry's major problem that of maintaining and increasing production in the face of diminishing man-power. At the same time, that there might be no possibility of failure in important armament applications, it has concerned itself with the maintenance of high standards of quality.

Increased use of mechanical equipment has been of some assistance. Metal composition has been altered in no important respect, although, in the case of duplex melting installations, and to somewhat accelerated annealing, the use of a slightly higher silicon content has been adopted by an additional number of foundries.

The malleable heat-conversion process, or anneal, has undergone no basic change. The required annealing time has been reduced in the case of a number of installations by the use of mechanical equipment which permits more rapid heating to the first (1600-1700 F) stage of the process, and more rapid cooling to the second (1350-1250 F) stage. It is noteworthy that there has been sufficient quality-consciousness to avoid reduction of the second-stage holding period, which would result in decreased toughness of the final product. On the contrary an increased realization of the importance of adequate low-temperature treatment in making for a high quality product, has been apparent.

The use of standard malleable iron, produced to A.S.T.M. and Federal Specifications, has been found as advantageous in combat vehicle (as in peace-time automotive) production. The driving of front, as well as rear, wheels has required additional differential carriers, cases, bearing caps, hubs, and other parts. These have been produced in tough malleable iron, with a minimum expenditure of machine tools and man hours. Heavy duty military trucks require 350 lb. rear axle housings. That these have been most effectively produced in malleable iron, may indicate an increased use of this relatively large type of malleable casting in post-war design and production.

At the start of the war, ordnance men planned but little use of malleables in arms, ammunition and bombs. They have since been active, however, in taking advantage of the castability, machinability and toughness of this material in gun parts, ammunition components and bombs. Both standard malleables and pearlitic malleables have found many uses, characteristics being demonstrated which may increase their field of usefulness in the post-war era.

Of interest to all concerned with engineering materials should be the first handbook on malleable iron. "American Malleable Iron—A Handbook," an authoritative treatise of some 400 pages, was published in December by the Malleable Founders' Society, Cleveland, Ohio.

Magnesium Alloys (Wrought) by J. C. MATHES, The Dow Chemical Co., Midland, Mich.

1944 has seen some outstanding developments in the use, production and development of magnesium wrought alloys. Most significant has been the installation of forging, extrusion and rolling equipment to make the country's capacity many times what it was before. Thus, when the demand came for rocket launcher tubing for our fighting aircraft, the industry was in position to produce this tubing in immense quantities within a very short time after the requirements were announced.

Forging and rolling capacities have likewise been greatly increased. The installation of a 5000 ton forging press in the plant of The Dow Chemical Company provides capacity for larger magnesium press forgings than were previously available in this country. In sheet production, installation of rolling mills by the Revere Copper & Brass Company has significantly increased capacity over that provided by White Metal Rolling & Stamping Company, the American Magnesium Corporation and The Dow Chemical Company, previously the only producers.

With the increased capacity for forgings, use of this form has increased appreciably, particularly in aircraft. Both hammer forgings of the 3.5% aluminum, 5.0 tin alloy and press forgings of the 8.0% aluminum, 0.5 zinc alloy are used, with the latter having some advantage for stressed applications because of its higher strength, particularly when aged.

Another event of 1944 has been the development of heat treatments for extruded alloys of the 8.0% aluminum, 0.5 zinc type, which give higher yield strengths, particularly in compression, than have been available heretofore. Originally developed by The Dow Chemical Company as an experimental alloy for their development of all-magnesium aircraft primary structures, this alloy is commercially available with minimum yield strengths of 30,000 p.s.i. in tension and compression.

Also developed in 1944 and just recently announced by The Dow Chemical Company is a new sheet alloy, having 5% aluminum and 1.0% zinc and designated as Dowmetal 251X. This alloy retains the strength and weldability of the previous 6.5 aluminum, 1.0 zinc alloy with substantially increased ductility and toughness.

Copper, Brass and Bronze (Wrought)

by R. A. WILKINS, Revere Copper and Brass, Inc., Rome, N. Y.

The products of the copper and brass industry are of critical significance in a war-time economy, and during the war years emphasis has been placed on volume production of certain basic items and the control of quality in such volume production. As might reasonably be anticipated, therefore, the significant advances in the industry in recent years have generally been in the field of manufacturing methods and metallurgical control, rather than in the direction of new alloy and product development.

Broadly speaking, it can be considered that the industry will be well equipped and in a good position to meet the heavy demands for its basic products that is anticipated in the post-war period. The general reversion to brass for shell cases and cartridge cases as soon as copper became sufficiently available again was an outstanding case of recognition of the unique suitability of copper alloys for many of their established applications.

There has been, of course, a continuing development of certain specialized products and alloys to meet specialized requirements. The engineering bronzes, both silicon and aluminum, found new uses and acceptance. Aluminum bronze extrusions became available and are now in use. Beryllium-copper continued to be in high demand for springs and other parts, with more widespread understanding of its metallurgy and potentialities.

We hear much of the future of the light metals—aluminum and magnesium—in a post-war world, as well as the possibilities for plastics and laminated wood compositions, as competitors of the heavy metals. Where such light metals and other materials would satisfactorily perform the function required in a given application, they have been widely used. In those now existing marginal fields of application where either the light metals or copper or brass could be utilized with adequate performance of function in either case and where relative price might be a determining factor in selection, a rather small percentage (5 to 10%) of the normal peace-time business of the brass mills would be involved.

The light metals and plastics will, in the future as in the past, find their own markets based on their own peculiar combinations of valuable properties, without any extensive or destructive inroads upon the established fields of application of the heavy metals. An active and prosperous post-war industry will see an active and expanding application of *all* engineering materials. It would seem fallacious to assume that an increasing and expanding application of light metals and plastics would cause a drastic reduction of the use of the heavy metals in those fields where the peculiar attributes and properties of the heavy metals have established their functional value.

Cast Copper Alloys

by HAROLD J. ROAST, Canadian Bronze Co., Ltd., Montreal

There has been a tendency under the pressure of the war economy to substitute copper alloys of lower physicals for the old standards. Before, however, we swing back to former standards, we should consider the effect of permanent mold and centrifugal permanent mold casting on what are looked upon as the lower grade alloys. In many cases, the improvement of centrifugal permanent mold casting is such that physical constants are in many instances doubled, thus making the product superior to the old higher grade metals cast in sand.

Silicon bronze that came into its own quite largely, until copper became a strategic metal to an even greater extent than tin, should again come into its own in the post-war days, as silicon bronzes are believed superior to tin bronzes for most if not all uses—with the exception of leaded tin bronze.

Two alloys have come to the fore in the war specifications, both of them aluminum bronzes, one with 10% aluminum, 1% iron, copper remainder, and the other with 10% aluminum, 3 to 5% iron, copper remainder. If these alloys get into post-war circulation, a warning should be given to the effect that the 3 to 5% iron alloy, slowly cooled in sand, can be extremely brittle. The same alloy, cast in centrifugal permanent molds, can be quite tough.

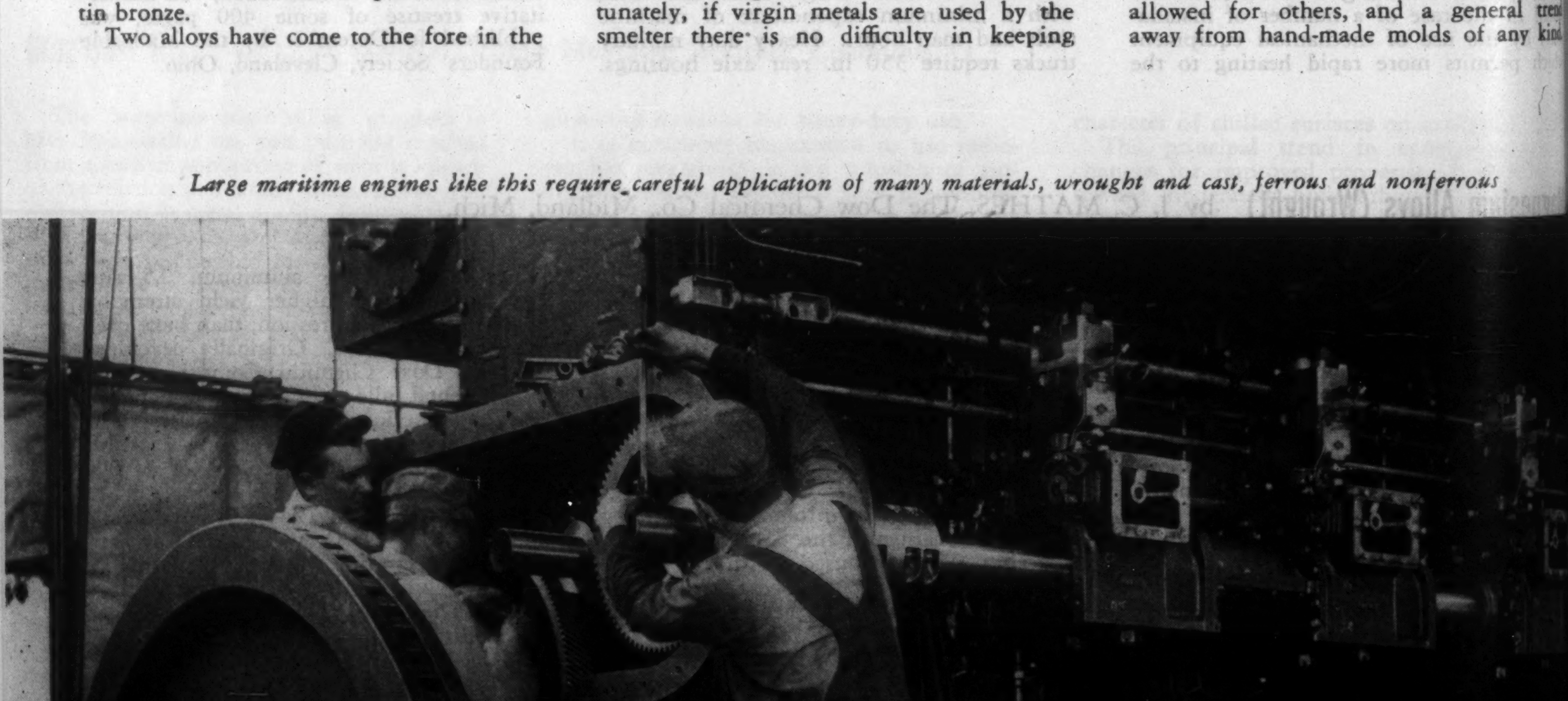
Many of us will have to revise our viewpoint as to the importance of small amounts of metal present in an alloy other than the essential ingredients required. One instance that might be given is the use of admiralty metal for compass parts. Although 0.25% of iron is permissible in a large number of ingot metal specifications, the iron content of brass for compass work should not, in the author's opinion, exceed 0.05%. Fortunately, if virgin metals are used by the smelter there is no difficulty in keeping the iron down below this figure, in fact frequently in the third decimal place.

On the other hand, larger percentages of lead have been shown to be acceptable in many manganese bronze materials. Where such allowances are permissible, an economy in the whole use of the metals can be made.

It should be borne in mind that frequently the surface and fracture tests in the foundry will be found to be much more sensitive than any wet method analytical tests for the presence of impurities inimical to the quality. (One excepts spectrographic investigations of metal.)

To sum up, the general tendency will be, as I see it, for some of the newer alloys to receive greater recognition, for greater care to be exercised regarding amounts of some impurities and greater latitude to be allowed for others, and a general trend away from hand-made molds of any kind.

Large maritime engines like this require careful application of many materials, wrought and cast, ferrous and nonferrous



Aluminum Alloys (Wrought)

by JUNIUS D. EDWARDS, Aluminum Research Laboratories, New Kensington, Pa.

Developments in the military situation have led to changes in the aircraft program, notably in a demand for bombers of longer range and greater load-carrying capacities, and for high-performance combat planes. This demand has accelerated the search for stronger aluminum alloys, a development which has been under way for years.

A special-purpose alloy, Alcoa X76S, which is a heat-treatable alloy having magnesium and zinc as the principal alloying constituents, has been in use for forged aluminum propellers for three or four years. During the year, another aluminum alloy, 75S, passed the development stage and was put into commercial production in the form of extrusions and Alclad sheet. Magnesium, zinc and copper are the alloying elements present in principal amount. This alloy is of particular interest because it is the strongest of the aluminum alloys.

Extrusions of this alloy have a tensile strength of 88,000 p.s.i. and a yield strength of 80,000 p.s.i., with an elongation of 10% in 2 in. Alclad 75S-T sheet has a tensile strength of 76,000 p.s.i., a yield strength of 66,000 p.s.i., and an elongation of 11%. These values, as well as the others cited, are typical mechanical properties.

Alloy 24S is still standard for aircraft structures and is the backbone of the aircraft program. No new information on the artificial aging of Alclad 24S sheet has permitted the strength of this product to be raised so that it remains a competitor of the newest high-strength alloys. The use of 75S is being extended rapidly and has amounted to over one million pounds in the last three months.

Reynolds' R303 is an alloy of the aluminum-magnesium-zinc type with high tensile and yield strengths, which is being tested with interest by aircraft manufacturers.

Other important developments have been the introduction of two alloy-clad sheet alloys of the aluminum-copper-magnesium-silicon type. These are Reynolds' R301 and Alcoa Alclad 14S. The properties of alloy R301 are relatively stable in the W or quenched temper and the material can be formed readily in this condition and then aged to its ultimate strength. It is a characteristic of all the alloys mentioned in this outline, that they are put in the hardest temper (T) by elevated temperature precipitation heat treatment (artificial aging) after quenching. R301-T sheet has a tensile strength of 69,000 p.s.i., a yield strength of 61,000 p.s.i. and an elongation of 9%. Because of its high strength and because of good workability in the annealed and W tempers, it is finding important applications in the aircraft field.

Alcoa Alclad 14S-T sheet also has an alloy core of the aluminum-copper-magnesium-silicon type with an alloy cladding and has good forming qualities in the W temper. After aging it has a tensile strength of 69,000 p.s.i., a yield strength of 61,000 p.s.i. and an elongation of 9%; these properties are in the same range as those of Alclad 24S-T81 (artificially aged).

Light Metal Casting Alloys

by R. E. WARD, Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.

Two major alloys still comprise the bulk of magnesium sand castings: the magnesium alloy containing 6% aluminum, 3% zinc, and the magnesium alloy containing 9% aluminum, 2% zinc. The former, although reportedly more susceptible to microporosity under equal casting conditions, has better salt water corrosion resistance which makes it preferable in many applications. Its lower heat treating temperature makes it less susceptible to distortion, and for this reason it is also desirable. However, its greater susceptibility to microporosity makes it less desirable for complicated castings and castings requiring pressure tightness.

Magnesium permanent mold castings are in the most part made from the magnesium alloy containing 9% aluminum, 2% zinc. Some, however, are made of the magnesium alloy containing 10% aluminum which is an early sand casting alloy. The latter has better casting characteristics but inferior mechanical properties. Relatively few permanent mold castings are made in the 6% aluminum, 3% zinc alloy.

Only one magnesium die casting alloy is in wide use; this being the alloy containing 9% aluminum, 0.5% zinc.

Owing to the long solidification range of magnesium alloys, increasing difficulty in preventing microporosity or hot tears becomes evident as sand, permanent mold, and die castings are compared. Although microporosity is still a major problem, satisfactory sand castings are made in several alloys as mentioned above.

Permanent mold castings, except for the most simple designs, cannot be made from the high zinc magnesium alloy due to their hot tearing characteristics, and, for this reason, it is necessary that the alloy of 6% aluminum, 3% zinc be discarded with the exception of simple castings. In the manufacture of die castings, only the low-zinc alloy produces sound castings and even this material requires considerable experience and careful attention to casting design and foundry technique. It is possible that the next year will introduce new alloys having better casting characteristics and comparable physical properties.

Interesting developments have been made with natural aging or low temperature aging aluminum alloys of the tin, nickel and of the zinc types. These are well adapted for large airframe castings where high strength is required and where the distortion due to high-temperature solution-heat-treatment of the regular alloys cannot be tolerated. Other applications where maximum physical properties are desired have resulted in an increased use of the aluminum alloy containing 10% magnesium, despite the necessity for special melting, pouring and heat treating techniques.

Lead Alloys and Coatings

by F. E. WORMSER, Lead Industries Assn., New York

Lead coatings, lead-base bearing metals, solders and applications of powdered lead have been responsible for the leading developments involving lead that are of major interest to the materials engineer.

Hot dipped lead alloy coatings continue to be an important military and civilian item in wartime. For a detailed discussion of the current position of lead coatings, the reader is referred to the article by Harold A. Knight entitled "Lead Coatings on Steel" in the November, 1944, issue of METALS AND ALLOYS. More knowledge has been accumulated about lead coatings, from the standpoint of application and expected life in the last three years, than in the preceding fifty years. Evidence is accumulating that the alloy type of coating is somewhat more corrosion resistant in the atmosphere than the pure metal type. Without doubt, lead coatings will find many peacetime applications. At the same time, interest has been intensified in the use of electroplated lead coatings, with the sulfamate solution being the newest electrolyte to be commercially used, with lead fluoborate believed to be most widely used.

As is well known, lead has replaced scarce tin in many lead-tin alloys, particularly bearing metals and solders. So satisfactory have some of these developments become that, far from being a war expedient, they are expected to carry over into the postwar period. A method has been developed for improving the bonding of lead and lead alloy materials to steel and cast iron so that the bonding problem is no longer an impediment to the use of high lead alloys in bearings.

Although many of the old high-tin content solders will return into circulation after the war, because of their desirable melting characteristics, some of the low-tin content solders containing only 2 or 3% tin have been used satisfactorily in the canning industry and may remain in that application. Lead-silver solders have also been used.

More attention is being paid to powdered lead in recent years, which has become an important constituent of clutch facings made from powdered metals, and also in lubricants.

Other uses that the war has evolved and which are under study as to their post-war potentialities include lead-foil and packaging seals for drugs, metal products, industrial parts, etc.; lead balance-weights in airplane construction; and steel-reinforced lead battery terminals—to mention just a few.

Zinc Alloys and Coatings

by C. R. MAXON, New Jersey Zinc Co., New York

Outstanding developments in the field of zinc and its alloys and coatings have been increasing engineering acceptance of zinc alloy die castings, electrogalvanizing and zinc alloy stamping dies.

At the presentation of the Distinguished Service Award of the Ordnance Department to The American Die Casting Institute on November 15, 1944, Col. John H. Frye emphasized the fact that "there has not been a single instance called to our attention where die castings have proved inadequate because of unsound engineering, soundness or other qualities under control of the die casting industry."

The recent greatly increased use of zinc alloy die castings in the war program has been due to the attainment of quality in a degree hardly thought to be attainable until now. Data recently published indicate that by utilizing new knowledge and new techniques, the impact values of zinc alloy die castings have been raised from 20 ft.-lbs. to over 40 ft.-lbs.

For galvanizing, using the same electrolytic lines that have revolutionized production of tin plate, there are now 26 units in the U. S. capable of turning out electrolytic zinc coated sheets. High purity zinc is being deposited on continuous strip up to 38 in. in width at a speed of 160 ft. per min. in coating weights up to 0.2 oz. of zinc on both sides, per sq. ft. of strip.

This development offers many possibilities in the expansion of the use of preplated metals, and the automotive industry is giving serious consideration to the possible use of such zinc coated steel for body stock. Consideration is also being given to the use of small stampings made from zinc coated steel, where the protection of zinc is carried over to the cut, unplated edges through electrochemical action.

Because of the uniformity of coating, the use of electrogalvanized steel wire has expanded with spectacular speed in the seven years since it was first produced, and several new units have recently been installed.

The experience gained by the automotive industry in the production of aircraft parts has considerably spurred their interest in the use of zinc alloy stamping dies. Work so far indicates that zinc alloy dies will prove useful in making both experimental and relatively low production stampings. They have, however, been used in the production of as many as 25,000 deep drawn stampings from 0.024 in. steel sheet, and as many as 1,000 blanks of 0.050 in. stainless steel sheet.

The dies are low in cost, can be made rapidly with a minimum of skilled labor, and are easily altered. Aircraft manufacturers found this procedure of importance because of frequent changes in design following experience in war service.

Tin Alloys and Coatings

by BRUCE W. GONSER, Battelle Memorial Institute, Columbus, Ohio

Although tin supplies have proved adequate for all essential needs, and the stock pile should assure filling such needs for several more years, consumption continues to be well in excess of imports. For the duration, then, and possibly for a year or two beyond recovery of the Southeastern Asia tin fields, tin will remain available only for essential purposes.

The electroplating of white bronze (high in tin) on steel parts as a stop-off in nitriding is being accepted as standard practice for certain classes of work. The comparatively high melting point of this alloy of copper and tin makes it much more effective than tin alone. White bronze plating for decorative and protective purposes is arousing wide interest among manufacturers, but very limited use can be made of the method until tin is in greater supply.

Currently, over 25% of the tin plate being produced is from electrolytic lines. These can make available a wide range of coating thicknesses, as from 0.10 to 1.0 lb./base box, to fit requirements. Of particular importance in the use of the thin electrotinned coatings is the recent development of a tin-plate filming treatment, combining an alkaline detergent with a corrosion inhibitor salt, which inhibits rusting under moderately corrosive conditions of humidity and outdoor exposure. This makes the exterior of thinly tinned electrolytic tin-plate containers more resistant to rusting than untreated hot-dipped tin cans.

The largest use of tin continues to be in bronze, largely because of the ship building program. No really effective substitutes have been found. Excellent progress has been made recently in an improved procedure for casting high tin bronzes to secure exceptional ductility. By using an oxidizing flux to assure removal of gases from the molten metal, deoxidizing and casting under conditions to secure directional cooling, sound castings are being made which can be extruded into wire, rod, and tubing, or stamped and hot forged. With 10% tin bronzes, a tensile strength of over 50,000 p.s.i. and elongations of 50-70% are obtainable by this procedure.

In soldering the side seams of cans at high speed, the use of a 5 per cent tin-lead solder has largely supplanted the silver-lead solders developed for this purpose to save tin a few years ago. Since the 2% silver-lead solders quickly picked up about 5% tin from the tinned cans, this change in omitting the silver has not materially increased tin consumption for this purpose.

Nickel and Its Alloys

by R. C. STANLEY, International Nickel Co., Inc.

Nickel was one of the first metals to be put on a priority control basis early in the emergency. The nickel requirements of the armed services, war production and essential services have continued at a high rate and have absorbed virtually the entire nickel supply. Therefore, the release of any appreciable quantities of the metal for civilian purposes must await cutbacks from the present rate of war orders.

The steel industry continued to be the largest consumer of nickel in 1944, requiring approximately two-thirds of the metal for the production of stainless and engineering alloy steels. The next largest consuming industries were those producing copper-base alloys and the nickel-chromium alloys for electrical and heat resistance.

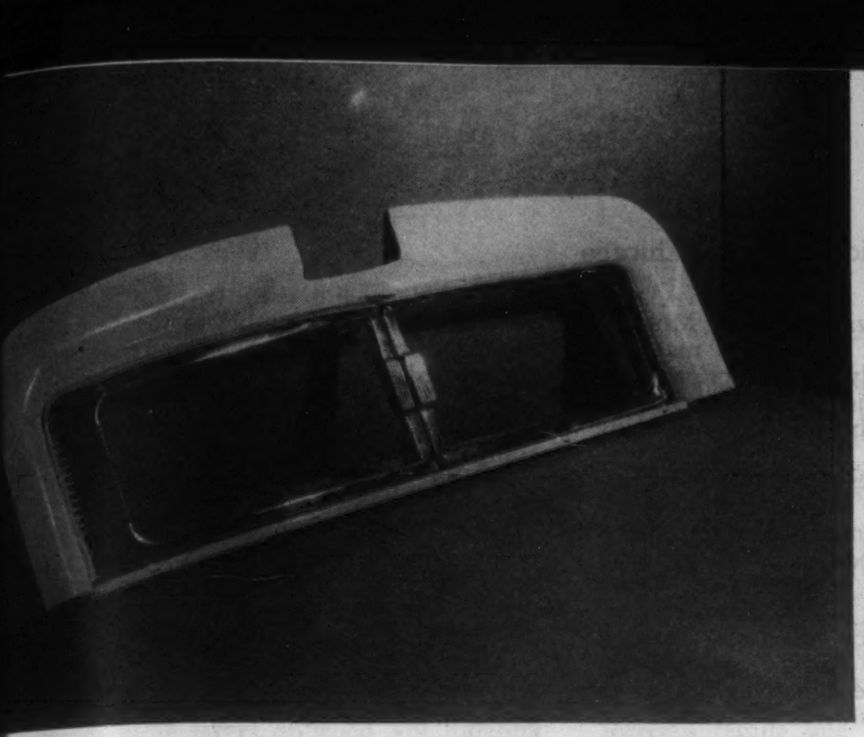
While figures for 1944 are not available, a relatively high rate of stainless steel production has undoubtedly been maintained this year. The use of these steels is currently confined to the most essential of military requirements, but the post-war era will no doubt see an even greater utilization of stainless steels.

The wide acceptance of the NE steels has made nickel of much broader usefulness to the United Nations' war efforts. Through them it was possible to apply the metal to a substantially larger steel tonnage to meet the requirements of the Allies. Enlarged utilization of the nickel-chromium-molybdenum alloy steels, including some of the NE types, is expected in the post-war era.

The consumption of nickel in brass rolling mills has gone principally into the production of cupro-nickel products used in marine construction, with small amounts also being employed in brass and bronze compositions. Nickel has not been available during the war for use as coinage, either in its pure state or alloyed with copper, and it has also been restricted for most uses of nickel silver, both of which applications should enjoy rapid recovery as soon as nickel becomes available for non-war usage.

War production of rolled nickel, Monel, Inconel and other high nickel alloys is expected to be substantially more this year than in 1943. The 1943 level was about twice that of 1937, when the highest peace-time level was reached. These nickel alloys are used in the equipment of the Army, Navy and Air Forces as well as for equipment in other war plants.

The Allied Armies are considerable users of these nickel alloys, but the largest amount produced goes to the Allied Navies, which have been substantial peace-time customers. Cupro-nickel, used extensively in pipe and tubing for naval construction, continued at a high rate of production this year. Military airplane production has created a large demand for Inconel and the "18-8" stainless steels.



A plastics refrigerator part

Masterpieces of materials engineering are these 20-mm. a.a. guns

Bismuth Alloys by J. D. TRETHAWAY, Cerro de Pasco Copper Corp., New York

The demand for bismuth as a component part of low-temperature-melting alloys has shown a marked increase since 1940 for use in a variety of applications directly connected with the war effort. At present, and for an indefinite period in the future, the War Production Board deems it necessary to limit the use of bismuth and low-temperature-melting bismuth alloys to only the most essential applications. These include many secret uses not disclosed at this time.

The great impetus in research in connection with war production has brought about a number of new applications of bismuth alloys. For several years prior to the war, low-temperature-melting alloys played an important part in simplifying various industrial processes such as: a filler supporting thin-wall tubing to prevent wrinkles and collapsing while being formed; a means of holding parts in dies and machine tools; master patterns; proof casting of irregular-shaped cavities; split jaw chucks for holding irregular-shaped pieces; liquid seal for nitriding furnaces; fusible plugs for safety devices; heat transfer medium in auto-claves; short-run-forming dies; models or templates for engraving machines; spotting fixtures and assembly jigs; fusible cores for hollow products made of plastics, ceramics, and metal formed by electrodeposition (electroforming). When war restrictions on these alloys are lifted, it is indicated that many of the now secret uses will serve a useful purpose in simplifying many complicated peace time applications.

Among the known uses which at this time show a tendency to develop are electroforming, spraying, free cutting alloys.

(1) *Electroforming.* The electrodeposition of metals, such as: nickel, copper, silver, iron on models or patterns made of low-temperature-melting alloy permits the manufacture of intricate-shaped products to very close tolerances at relatively low cost as compared to other methods of fabrication. To cite a few of these: aircraft accessories; parts for electronic equipment; molds for plastics and ceramics; forming and embossing dies; engraving machine models; costume jewelry and ornaments.

(2) *Spraying.* Due to the development of relatively inexpensive electrically heated spraying equipment, it is possible to metal-coat patterns and core boxes to resist wear and warpage and to produce high-fidelity reproductions of contours and surface finishes necessary in the making of molds, dies, and master patterns.

(3) *Free-cutting alloys.* The addition of traces to fractional percentages of bismuth or bismuth-lead to aluminum alloys, stainless steel, manganese steel, carbon steel, cast iron, and some other alloys has shown very marked increases in the machinability of the resultant alloys.

Noble and Rare Metals by EDWIN LAIRD CADY, Contributing Editor, METALS AND ALLOYS

For the first time in their histories, many of the rare and precious metals are being used in large enough quantities to make real application engineering of them practical. Unfortunately, many of the applications are "military secrets." But it is clear that the war developments will remain as postwar markets to a large degree.

Alloying with more common metals to provide free machining qualities is an example. An engineer of Molybdenum Corporation of America has applied for a patent on the alloying of boron with steel screw stock for this purpose. The claim is that with addition of 0.004 to 0.005 boron, 0.07 sulphur stock will machine as freely as 0.30 sulphur stock will without the boron. Tellurium is alloyed with Invar and with copper for free machining. Selenium is increasing in use in stainless steel; it permits finer cuts to higher tolerances in that fast-work-hardening material. Free machining will still be a highly desirable quality after the war.

Industry's ever increasing use of higher accuracies of bearing surfaces in order to support higher pressures on smaller areas, is increasing the use of silver and of indium. Silver is liked for its high ability to conduct heat; it can get the heat away from the point of friction. Furthermore, silver has extremely high fatigue resistance under heat and pressure. An engineer of an airplane engine manufacturer said: "there are eight makers of silver bearings now. . . they have licked the problems that bothered us last year. . . you will see silver used on plenty of pressure areas other than crankshaft bearings."

Indium diffused into 0.0005 in. to 0.001 in. thick layers of lead or else directly into the surfaces of harder metals, is being used on wire drawing dies, deep drawing dies and other heavy pressure areas as well as on bearings. It is being tried on the surfaces of gear teeth which are finished to the order of 5 micro inches; those teeth tend to stick and to refuse to accept lubrication when made of bare steel. Silver-lead-indium bearings have attained coefficients of friction as low as 0.001.

Ruthenium as a hardener of platinum, palladium and other precious metals was known before the war, and yet it is one of the most rapidly growing war developments in this field. Ruthenium in palladium alloys for jewelry is being increased from the former 4% to the present 5%; the higher ruthenium alloys are harder and take much better polishes with resultant higher beauties and greater marketability.

No rare or precious metals can be discussed without electrical contacts being mentioned in the conversations. The contacts makers are alloying or sintering platinum, gold, silver, palladium, iridium, tungsten, and all the rest, and seem to have a different combination of metals for almost every electrical problem.

Chemicals ware is in similar case. The use of platinum-clad copper and other insoluble anodes is growing. Silver is increasing its use in chemicals ware; a spokesman for Handy & Harman expressed the belief that this is one of the least developed but most promising markets for silver.

Fabrication facilities are more complete. An engineer of I. Stern & Co. said: "before the war we had no facilities at all as compared to now . . . we draw shells deep enough so we can cut off 18 collector rings from each as compared to 3 per shell prewar. . . we can clad, laminate, roll and draw at production costs much lower than our prewar ones."

Developments like these will cause the rare and precious metals producers to become far more widely useful to industry than they were before the war and to increase general appreciation of them.

Plastics

by JOHN DELMONTE, Plastics Industries Technical Institute, Chicago

During 1944 the new developments in plastics materials and their processing methods were closely allied to the war program. In many instances their specification and application were dependent upon newly created material specifications, prepared by the ASTM and Federal agencies, which are now defining property standards as well as the testing methods.

Several materials which have been under investigation in various laboratories for quite some time made their commercial appearance during 1944. Various papers were published upon the silicone resins and their ability to withstand very high operating temperatures. Greatly improved electric motor horsepower output promises to be one major contribution of silicone resins as electrical insulation.

The emphasis which has been placed upon raising the operating temperature limits of plastics has been reflected in two new modified polystyrene compounds, both capable of heat distortion points above 220 F. One of them is polydichlorostyrene and the other a styrene base modified with a small amount of divinylbenzene. Molding compounds prepared from these materials are limited exclusively to high priority applications, though they point the way to the trend toward high-temperature resisting plastics.

Improved adhesives made their appearance on a wide scale during 1944. "Metlbond" adhesives for metal were introduced as well as the "Redux" adhesives from abroad, to take their places beside "Cycleweld," "Reanite" and others. For the bonding of solid plastics materials, furfural "Resin X" adhesives and "Penacolite" resorcinol formaldehyde adhesives proved to be outstanding. Considerable attention was being given to the application of plastic materials as metal bonding agents, and considerable progress was evident in this direction.

In May 1944 the secrecy surrounding the development of laminated woven glass products was lifted by the U. S. Army and the high strength laminates prepared from newly developed thermosetting materials were revealed. Strength-weight ratios were very high and comparable to the best aluminum alloys. Experimental aircraft were constructed with sandwich laminates comprised of a skin of laminated glass and birch core. These laminates are now generally known as low pressure or contact laminates inasmuch as they require little or no pressure while undergoing cure.

Other developments in plastic laminates received much publicity, such as the rocket firing tubes slung on the wings of an airplane. The rocket program expedited this development to large proportions.

Among the more rubber-like materials, activities in the polyethylenes were publicly disclosed in 1944, though the materials have been in use abroad for several years. Possessing outstanding chemical resistance and flexibility at low temperatures, they are fulfilling many important requirements as insulating materials.

Equipment developments were not far behind the materials, and thermosetting extrusion, as well as high frequency dielectric heating methods and equipment, attracted much attention.

Vulcanized Fibre

by F. L. STIEGLER, National Vulcanized Fibre Company, Newark, Del.

In 1859 the first patent was granted on the zinc chloride process for making vulcanized fibre and soon thereafter vulcanized fibre became one of the first plastics to be made commercially. It is a non-corrosive material having an unequaled combination of chemical, physical, and electrical properties. The standard forms are sheets, tubes and rods, which in turn can be formed, drawn, machined, swaged, punched, or threaded in the preparation of various specialties. Because of the urgent demands of the armed forces, it has become necessary to divert vulcanized fibre from the nonessential prewar applications to those applications needed in our war effort program, and the material is therefore under allocation restrictions.

An outstanding development is the use of a special grade of vulcanized fibre for aircraft fuel tanks and the reinforcing members thereof. The jettison fuel tanks are made entirely of vulcanized fibre, whereas the built-in bulletproof fuel tanks are made with vulcanized fibre as only one component of the complete assembly.

The rigorous performance demands for modern aircraft have resulted in the use of self-locking nuts in aircraft construction. The type of self-locking nut that most readily meets the government specification requirements covering that part is the one containing an insert of vulcanized fibre, used because of its hardness, resiliency, toughness, elasticity, plasticity, and high ultimate strength. Since a large four-motor bomber contains approximately 50,000 lock nuts and the production rate of aircraft has been very high, the demands of the lock nut industry alone have been tremendous. In addition to aircraft, lock nuts are used in tanks, jeeps, and other military equipment subject to any degree of vibration.

An unusually large demand has developed for welders' shields made of vulcanized fibre, and for electrical fuses in the manufacture of which vulcanized fibre is required. Vulcanized fibre is extensively used in machine guns, in the form of buffer discs in the recoil chambers.

The war effort has resulted in great demands for vulcanized fibre for use as containers of a wide variety of types. It was considered necessary to use some material which would effect adequate protection of the contents by virtue of its ability to withstand shocks from external blows such as are suffered by containers being handled in overseas shipment. Among the many types of containers made of vulcanized fibre, a few are map cases, sign storage cases, sign reproduction cases, data cases, cartridge cases, barber supply cases, amphibious boxes, spare parts and repair kits.

The scarcity of available metal created by the war has resulted in a partial replacement of metals by vulcanized fibre for such items as file fasteners, file hangers, and nameplates of very many types. Thus it appears by virtue of the trend of applications, that vulcanized fibre is a veritable implement of war.

Glass for Engineering Use

by T. J. THOMPSON, Corning Glass Works, Corning, N. Y.

During the war years glass has become an important engineering material, with new types of glass and processing methods contributing to its industrial utility.

Outstanding among the new forms of glass have been the Fiberglas-plastic combinations—low-pressure laminates of very high strength that have been used for aircraft structures. The materials have, in addition, many potential peacetime applications such as luggage, furniture, automobiles. Fiberglas impregnated with new silicone-plastics provides an outstanding new electrical insulation, which permits reduction of size and weight of electrical motors.

Another new product is Flake-glass—glass in the form of small thin flakes approaching one micron in thickness for paints and decorative finishes. Then there is ribbon-glass—glass drawn in the form of thin, narrow ribbon 2 to 3 in. wide by 0.003 in. thick. It is now used mostly with thin metal foil to make compact hermetically sealed capacitors for radio.

Highly interesting among new glass-forming methods of interest to the engineer is multiforming, which permits the manufacture of small intricate glass parts of controlled electrical and chemical characteristics for use in radio and other electrical equipment, and also for mechanical parts such as buttons, coffee percolator baskets, etc.

The recently developed electrical welding of glass makes possible continuous, jointless pipe lines of glass for chemical, food, drug and dairy plants and also facilitates the fabrication of complex glass equipment for chemical and mechanical applications.

The precision forming of glass to precise tolerances as low as 0.0001 in. provides extremely accurate bore and contour of mechanical parts such as Rotameters, cylinders, gages, etc. New methods and equipment now permit accurate grinding of precision gages, ball-and-socket joints, optical lenses, mechanical and electrical parts to very close tolerances.

Among significant new applications, the following may be mentioned: Heavy plate glass is now being successfully used for large chemical processing tanks and coal chutes of plate glass outwear steel. Pyrex plate glass is now made in large sheets up to 30 in. by 30 in. and 3/8 in. thick.

Jewel-bearings of glass have displaced more expensive sapphire in many instruments. Sanitary glass piping for dairies simplifies cleaning procedure and assures improved sanitation.

Metalized glass is a new material and process that permits a simple, strong, soldered bond to metal parts and is now used in radio and electrical equipment to provide permanent hermetical seals, as well as the spiral metal coil or other metal parts in coil-forms, condenser shafts, etc.

Plywood and Other Woods

by L. J. MARKWARDT, Forest Products Laboratory, U. S. Department of Agriculture, Madison, Wis.

Unprecedented war demands have required a greater quantity and larger variety of wood and plywood products than ever before, and leave wood as one major material which has shown no improvement in supply. Much research and development by industry, by the Forest Products Laboratory, and by other research organizations is taking place, and many significant adaptations and new products have been developed. Among the most important have been the following:

Glued laminated construction, which is two or more layers of wood (of different types or sizes if desired) glued together with the grain of all layers parallel. The method is effective in utilizing more effectively wood in smaller sizes, and permits the fabrication of structural members of practically any size or shape, using waterproof phenolic glues if desired. One of the most striking and important applications involving the waterproof glues has been the laminating of large size boat and ship keels.

In *plywood*, the orthotropic structure of wood is further diversified by a reorientation of the material, so that plywood consists of three or more sheets of veneer glued with the grain of alternate plies usually at right angles. Plywood may hence be considered as a design-construction infinitely adaptable to specific strength and use requirements by varying the number and thickness of plies, the species, and grain direction. Extensive research has been under way to develop design criteria for plywood, including the flat and curved plate problems. *Impreg* is resin-treated wood that has not been compressed. A moderate weight increase results due to the resin, accompanied by some improvement in compressive strength, but more significantly by greatly increased dimensional stability (reduced shrinking and swelling), decay resistance, electrical resistance and acid resistance. *Compreg* is the general class of densified product comprising resin-treated and compressed wood, usually in the form of a laminated material.

Staypak is the densified product resulting from compressing wood under conditions of moisture content and temperature that cause sufficient flow of lignin to relieve internal stresses and thus avoid the spring back under the moisture exposure condition inherent in ordinary compressed wood. No resin is employed when it is made from solid wood.

The density of either Compreg or Staypak may be 1.35-1.40, approaching that of wood substance. While not dimensionally stabilized like Compreg, Staypak is about twice as tough, and has high values in tension, flexure, and modulus of elasticity.

Uralloy-A is the name given to wood treated with urea. Uralloy-A is a thermoplastic and when heated may be bent readily to curved form or twisted, the formed shape being retained when cooled. *Papreg* is resin-treated compressed laminated paper. Papreg has a tensile strength of 35,000 to 40,000 p.s.i. for parallel-laminated constructions, and can be processed with varying properties to meet special requirements. It can be moderately post-formed. Recent research has shown the feasibility of laminating with pressures as low as 50 p.s.i., greatly facilitating molding of special shapes.

Synthetic Rubber

by E. G. KIMMICH, Goodyear Tire & Rubber Company

Accelerated by a need for stringent conservation of the nation's natural rubber stockpile, the rubber industry converted more rapidly and more efficiently in the last year to synthetic rubber than probably would have been possible in peacetime. This is especially true with respect to mechanical and molded rubber items—transmission, conveyor and elevator belts, hose of all types, V-belts, rolls for printing and other purposes, vibration absorbers and dampeners, tank and pipe linings, molded products, gaskets and packings, and extruded items.

In many cases, the switch-over to synthetic rubber has been accompanied by certain advantages over natural rubber, particularly where resistance to oils, acids or detergents is desirable. In addition, we have found that synthetic rubber for mechanical rubber goods also withstands wider temperature ranges. As a general rule, it can be said that production of synthetic rubber items required more time and more care than similar products with natural rubber.

It is particularly fortunate that synthetic rubber is available and adaptable to aircraft requirements although engine and instrument mounts are still made of natural rubber—as is true also in the case of the latest captured German aircraft. Synthetic rubber, because of improvements in its manufacture, compounding and processing, is now sufficiently versatile that any one requirement can usually be obtained.

We have found that the mere accomplishment of a desired physical property in a particular compound is not the whole solution of the problem of conversion. Synthetics with excellent low-temperature properties are available but it usually is not possible to combine all optimum properties in a single compound. One that stays flexible at depressed temperatures may not also withstand the required elevated temperatures, or having withstood it, then again pass the low-temperature test.

In the case of airplane instrument mounts, conversion to synthetic has not yet been made—very largely because low temperature transmission elimination has not been accomplished as well as with natural rubber. Creep or drift in synthetic rubber has been difficult to control within acceptable limits but much progress is being made.

Another great advance has been made in the adaptation of synthetic rubber for seat cushions and backs, parachute seat pads, camera closures, crash padding and similar purposes. It should be noted, however, that generally the synthetic rubber substitutes now available for foamed latex in these applications are not considered quite the equal of the natural rubber product.

With regard to the overall problems on synthetic rubber and its use, the picture is a bright and encouraging one in the light of progress we have made in the past and developments which we are able to see before us. The industry is proud of its progress in synthetic rubber and confident that many improvements are still possible.

Structural Ceramics

by W. A. KOEHLER, West Virginia University, Morgantown, W. Va.

Clay products were among the first structural materials used by the earliest civilizations, and it is interesting to observe that today, with all our wealth of materials, brick is still one of the staples of the building industry. So is ceramic tile. Other structural ceramics have been added, such as glass brick and hollow tile, and all are basic building materials.

Manufacturers of brick and building tile have become interested in modular masonary, intended to standardize sizes and thereby reduce manufacturing and construction costs. In modular design all bricks and tile are dimensioned on the same basis, the four-inch module or increment. A brick, for example, plus one mortar joint along any surface will measure 4 in. or a multiple of 4 in. Allowing a half-inch for the mortar joint, a brick 3½ in. wide, 3½ in. high and 7½ in. long, with a ½ in. mortar joint on three faces would give a dimension of 4 x 4 x 8 in.

Structural tile would likewise be dimensioned by the same modules. Modular construction has been tried in certain areas and no unforeseen difficulties have been encountered. The City of New York has designed over ten million dollars' worth of buildings based on modular dimensions.

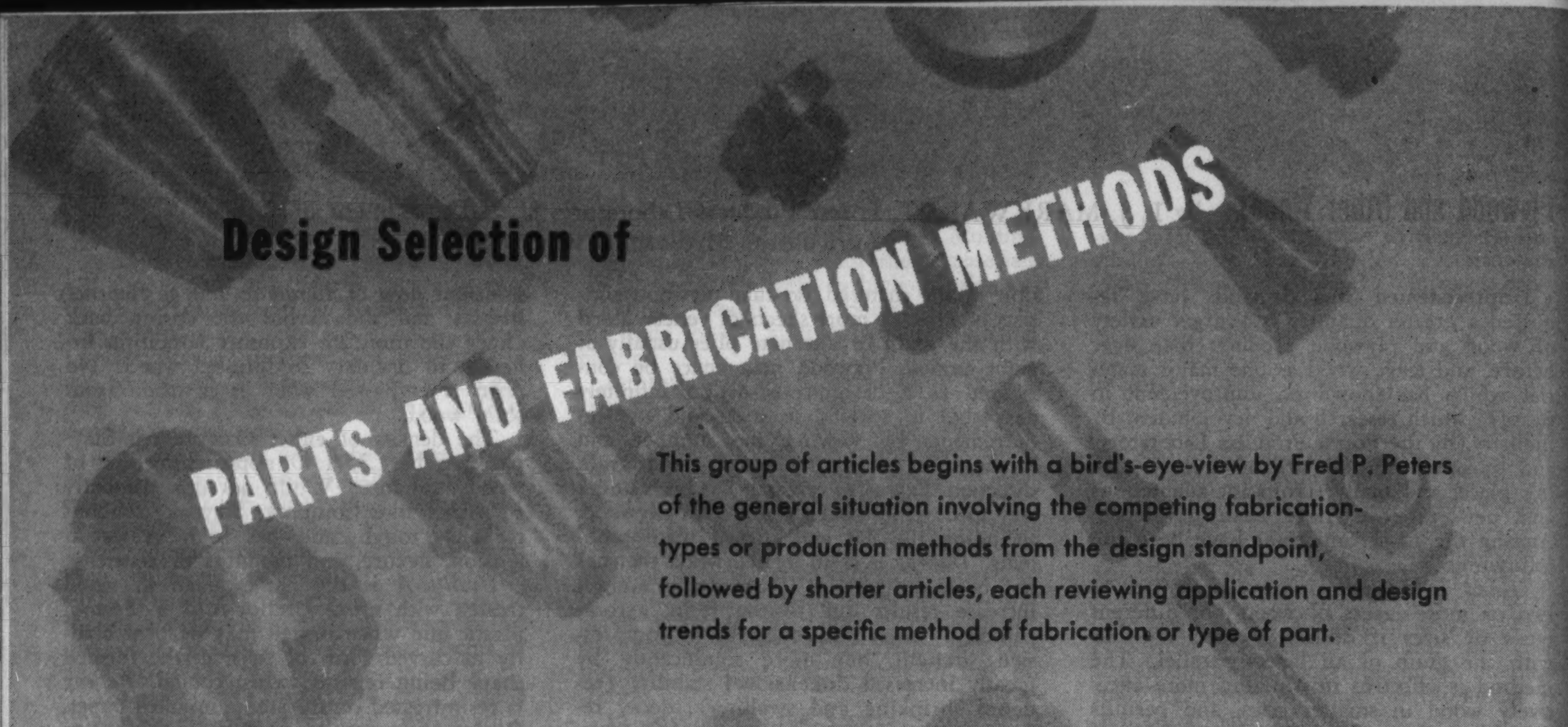
Development of the process of tempering glass has made that ceramic more useful in construction. The glass after being cut to proper dimensions is heated to within its annealing range, and suddenly cooled; the outside of the glass contracts and becomes firm, while inside it is still much hotter and in a partially fluid condition. As the inside cools its tendency is to contract also and in so doing it puts the outside surface in compression and the inside as it becomes rigid goes into tension.

It is the high compression on the outside surfaces that gives tempered or thermally toughened glass its greater strength.

When such toughened glass does break the whole glass breaks into many small, interlocking fragments which are much less likely to inflict serious injury than fragments of ordinary annealed glass. The glass must be cut to proper dimensions before it is thermally toughened. Any surface polishing must precede the toughening process.

The modulus of rupture, measured by transverse bending, is approximately 5 times that of ordinary plate glass, roughly 35,000 lb. p.s.i. as compared to 7,000 p.s.i. The glass will bend appreciably under load and will resume its original shape when the load is removed. Molten lead can be poured on a ¼-in. tempered plate glass resting on a cake of ice without breaking the glass.

Tempered glass has many uses—for glazing doors and windows, especially in public buildings, for skylights, green houses, shelves, fire screens, kick-plates on doors, porthole glass on ships, automobile rear lights, oven doors, and high tension insulators. In the pin type insulator the space between the metal pin and the glass insulator can be filled with a molten antimonial lead alloy as a coupling medium.



Design Selection of PARTS AND FABRICATION METHODS

This group of articles begins with a bird's-eye-view by Fred P. Peters of the general situation involving the competing fabrication-types or production methods from the design standpoint, followed by shorter articles, each reviewing application and design trends for a specific method of fabrication or type of part.

Parts and Fabricating Methods from the Application Standpoint

by FRED P. PETERS, Editor-in-Chief, METALS AND ALLOYS

Few trends in the design of industrial and military products have been as marked in recent years as the increase in importance of and the growing amount of attention paid to the selection of the method by which a part or product is to be fabricated. Indeed, the choice of fabrication-type—that is, whether a part under consideration should be a stamping, a forging, a die casting, a screw-machine product, a powder metallurgy compact, a welded or brazed assembly, etc.—is now given as much study in most informed engineering departments as is the selection of the material (aluminum alloy, carbon steel, brass, plastics, etc.) to be used, for the two obviously go hand in hand.

Along with this careful attention from all angles to the selection of the best form or fabricating method for a part, there has developed a highly desirable practice of applying specific design principles for individual fabrication-types. Here again it may seem that such practice should have been axiomatic, yet it is no exaggeration to say that a few years ago it was common procedure to take a part that had originally been designed as a forging or a stamping and attempt to manufacture it without any design change whatever as a sand or a die casting or a powder metallurgy part.

Today it is generally recognized that each fabrication type has its own design characteristics and limitations as to overall size, wall thicknesses, change of section, permissible cross-holing or undercutting, materials that can be used, amount of filleting, finishes possible, speed of production, optimum lot sizes, etc. Specialists in designing for die casting, for powder metallurgy, for forging, etc. are increasingly common in the users' as well as the part-producers' plants, and the result has been more intelligent design of these specialized forms and a correspondingly greater appreciation of the actual possibilities of many of them in place of the former and frequent black eyes they received because of failure to adapt a design to the production method.

Looking at the forms themselves, it is difficult to describe definitely the trends in the increase or decrease in use of the individual types. The war has of course impelled expansion in use of those parts that could be made of the less critical materials (such as steel stampings, gray iron sand castings, plastics moldings, iron powder parts, etc.) and of those that involved little or no use of machine tools or forging machinery and a minimum use of manpower (die castings, sand castings, plaster-mold castings, powder metallurgy parts, precision castings, stampings, welded and brazed assemblies, etc.). Not all of this expansion can therefore be considered permanent, and some of the substitutions will certainly be displaced by the original forms when normal production conditions return.

On the other hand certain of the "newer" fabrication-types have had a chance to demonstrate their value and have "caught on" with a vengeance. Precision (lost-wax) castings, for example, have been used and manufactured by engineers and companies who had hardly heard of such parts before the war, and they have demonstrated their utility for products that are too complex for die casting or powder metallurgy, with dimensional tolerances too close for sand casting and made out of materials that are unworkable by machining or forging. The rise of precision casting as a production method for industrial parts has undoubtedly been the most spectacular in this field.

Precision casting, however, is in about the same position that powder metallurgy was in five or six years ago—surrounded with an aura of glamour and novelty and drawing unto itself many people and applications that did it no good at all. Today powder metallurgy is recognized as one of our most useful methods of making certain types of parts to accurate dimensions and at low cost, but its limitations are also widely publicized and understood; misapplications are therefore fewer, and although the method has not quite found all the sensational applications that its more enthusiastic proponents predicted, it is now on a sound application-engineering basis and is making steady and sure progress.

Improvement in their metallurgy has done much to further the appeal and use of sand castings. Gray iron is now an engineering material and is increasingly employed for products once considered outside its range. The expansion in use of centrifugal castings and of plaster mold castings is also worthy of note. In fact castings of all types have more than maintained their engineering position during the war period.

A nonmetallic fabricating method that has made great strides recently and which has considerable significance for the future is the laminating of plastic materials to give composite materials (plywood, plastics, paper, fibre, etc.) that have engineering properties approaching those of some industrial metals and alloys and which are serving successfully in such engineering applications as gears, cams, levers, etc.

Welding and brazing have established themselves as the ideal methods for manufacturing certain types of parts, and fabricated assemblies are much more prevalent than they were a few years ago. Often they save materials but in an even broader sense they frequently permit the production of a product that might not be economically possible by any other method.

In fact, although each method of whatever type competes to a considerable extent with one or two others and to a smaller extent with several others, each also has its own special field of application where it is clearly supreme. It is in the direction of the understanding of that field by design and production engineers and the special cultivation of primarily that field by the part manufacturers concerned that we may expect the greatest progress in more intelligently specifying the various fabrication-types and parts.

Sand Castings by N. F. HINDLE, American Foundrymen's Assn., Chicago

At the beginning, this war was said to be a "steel war," but gradually, it became evident that such was not the case. It was found necessary to have a specific metal to meet the requirements of a given application. Rolled and forged products were given first consideration. Gradually, however, the basic necessity of castings of all types finally was recognized and today, cast structures are fulfilling the requirements of even the most drastic applications.

As a result of this recognition of cast structures, engineers have become more conscious of the potentialities of the sand casting process and have realized that there are certain fundamental design requirements to be met in order to achieve the best possible product. As a result, designs have been made to take advantage of the casting process and still develop desired properties in applications heretofore thought impossible.

Some of the most important developments are the successful use of malleable iron castings for valves and unions up to 4500 p.s.i. test pressure, the recognition that gray iron can be used up to 650 F in unfired pressure vessels, the increase of 50 to 150 per cent in the strength-weight ratio in military piston rings made from gray iron and the use of that material in large diesel crank shafts weighing up to 10,000 lb.

Of particular interest to engineers should be the fact that microporosity, so long the bane of the magnesium casting industry, now appears well on its way to solution, and this should enlarge considerably, the application of magnesium castings.

With steel castings a clearer understanding of the use of alloys and the development of quenching procedures to cover a wide range of design and physical properties have resulted in applications previously believed to be impossible.

Considering the sand casting field as a whole, it might be said that while this fabrication method might originally have been considered as a substitute method in the war effort, the performance of castings both in the field and in war industries at home has demonstrated to the engineer that castings can be used in many applications which they had not considered for them. It is quite probable that some of the new applications will revert to the original material and processes after the war, but it is believed that a large number of the applications developed will be retained because of satisfactory performance of products manufactured by the sand casting process.

Permanent Mold Castings by E. G. FAHLMAN, The Permold Co., Medina, Ohio

The intensified use of permanent mold castings (especially aluminum alloy castings) instead of sand castings continued throughout 1944. There were published two authoritative articles on this type of casting and the process for its manufacture —one by J. Vickers published in the A. F. A. Transactions for Sept., 1944, and the other by A. Vath published in the Nov. 1944 issue of *Light Metal Age*.

The first article states that out of 130 castings on the Rolls-Royce engine, 103, are produced as aluminum permanent mold castings. The advantages over sand castings resulting in this use are stated to be smoother finish and closer dimensional accuracy, greater possible speed of production, conservation of raw material, reduction of production scrap, and improved mechanical properties in the castings.

In this country also the largest use for aluminum permanent mold castings has been for aircraft purposes as components of aircraft engines, air frame structures and components for auxiliary aircraft equipment. Their increased use has been chiefly because of increased knowledge and recognition by engineers and metallurgists of their advantages.

The second paper referred to above gives details and much more information in regard to limitations of the process and why many sand castings can not be converted into aluminum permanent mold castings.

Today it is fully recognized by designing engineers and metallurgists that a properly designed and produced aluminum permanent mold casting has not only smoother finish and closer dimensional repetitiveness (the latter being most important to production machine lines) but also has greater strength than sand castings in the as-cast condition, and greater strength in heat treated castings over that of aluminum castings made by any other process.

They also recognize that such castings have the greatest uniformity of strength from one casting to another. This has resulted in the redesign and adoption of permanent mold castings in place of sand castings and important weight savings because of lower design factors with just as much safety for many aircraft engine, air frame and auxiliary castings.

Thinner sections for the same strength and less material for finish because of more accurate dimensions result in conservation of material when castings are made from this process.

From a standpoint of cost there also has been developed during the war both the required strength and soundness from alloys coming from remelt sources. Neither of these considerations, because of available supply of aluminum in 1944, has been as essential as it was earlier and will be postwar.

Welded Construction by KENNETH ROSE, Engineering Editor, METALS AND ALLOYS

During the past decade the status of welding has changed from that of primarily a repair and maintenance technique to a fabricating and production method. This change has been accelerated tremendously within the past several years with the demand for enormous quantities of war materials. With the acceptance of welding as a production technique there has come, more slowly, a willingness to design for welded construction.

If maximum benefits are to be obtained from the use of welding, the designer must lead the way. It is not sufficient to mark on a blueprint for a casting or forging the words "welded construction"—the part must be designed as a weldment. Proper design will result in greater economies of material, less welding will be required, a more efficient structure will be obtained, and there will be less locked-up stress.

The value of design in effecting economies is apparent as soon as the possible advantages of welding are considered. A lighter and stronger product may be had through the use of more dependable materials; less machining may be necessary, with a better surface on unmachined parts; a lower initial cost may be realized by elimination of patterns or dies; a lower scrap loss after machining may be anticipated because of the fewer defects in sheet stock.

An added incentive to the use of welding is the large number of welders and welding machine operators now available. Hundreds of thousands of persons have become associated with welding during recent months. Techniques have been developed for welding metals and alloys that were formerly difficult, such as aluminum, magnesium, and alloy steels. Dependable welds can now be obtained in steel armor. Resistance welding techniques and equipment have made possible high production joining of metals, with unskilled or semi-skilled operators.

Adaptations of familiar welding methods to new uses exemplify the versatility of these joining processes. Resistance welding joins not only tiny wires in vacuum tubes, but railroad rails also. Thermit welding, familiar in repair of heavy steel parts, becomes a production technique for joining steel castings into ship stern frames. Gas welding and arc welding, both hand and machine, are adapted to war production, as in silver brazing, ship hull construction, and tank armor fabrication.

The skills now being developed in solving war problems may be expected to carry over into peace time production, and to assure expansion of the use of welding. This will be aided by the growing practice of designing just for welding.

Die Castings by DAVID BASCH, General Electric Co., Schenectady, N. Y.

The outstanding activities in the application engineering of die castings during the year 1944 have been directed towards improvement and increased dependability, particularly in aluminum and magnesium.

In the aluminum alloy field, there has been a noticeable trend toward concentration on fewer compositions, making for greater familiarity with and knowledge of the alloys handled and for simplification of melting routine, metallurgical control, equipment, scrap handling, etc.

Three alloys are finding most application. The 8 per cent magnesium-aluminum alloy offers the best combination of strength, ductility, and corrosion resistance, although it is not so easily handled as the other commercial compositions.

The 13 per cent silicon alloy is still the most commonly used on account of its castability; but a variation of this alloy with only about 10 per cent silicon is gaining in popularity since, especially in cold chamber machines, the high silicon content of the 13 per cent silicon alloy frequently induces eutectic segregation in the form of plates and needles which break up the metallic continuity of the structure and reduce the physical properties. Reducing the silicon to about 10 per cent greatly obviates this trouble without affecting the castability materially. In order to make up for lower tensile strength due to lower silicon, small percentages of magnesium are added.

The third alloy, for general utility purposes and strictly a low cost remelt material, has about 3 per cent copper and 9 per cent silicon. It has good casting properties, low cost, and reasonably good physical properties although not so good as the other compositions. Its corrosion resistance is less.

The most important activity along the line of general improvement and broadening the scope of application of die castings covered intensified metallurgical and engineering control in the die casting plant, stricter acceptance requirements agreed on between vendor and purchaser, and a thorough study of the factors in machinery and operation to determine to what extent each one by itself and in combination with others affects strength, reproducibility and dependability of die castings. One of the reasons why die castings in the past have been largely limited to structurally nonresponsible jobs has been the difficulty of maintaining uniformity of the product throughout continued production.

Enough progress has already been made to show that slight variations in operating cycle, machine set up, etc. may cause marked changes in structure and properties. The prospects for producing regularly castings with good structure and guaranteeable minimum physical properties are excellent, and it is now even possible to obtain castings free from gas and air inclusions which will lend themselves to high-temperature heat treatment or high-temperature service without blistering or swelling.

The services as well as industry are already permitting so-called controlled quality die castings for vital, critical applications where failure might mean injury to the operator of the assembly containing the die casting or failure to carry out important functions. Hope may be entertained that the improved controlled quality die castings, especially those made in some of the newer high-pressure machines, will be able to enter the structural field in competition with forgings etc.

With respect to zinc and copper base alloy die castings, the outstanding developments have been simply a trend toward the specification of zinc alloy die castings for war purposes once considered beyond their suitability and a continuing interest in brass die castings for heavy-duty parts where cost is not a factor in their production.

Centrifugal Castings by W. P. GOBEILLE, Ampco Metal, Inc., Milwaukee, Wis.

In the design of specific parts, the design engineer must be familiar with the various methods of manufacture in use today and base his decision on this knowledge. Producers of centrifugal castings have discovered during the war that a large proportion of their products were originally designed as sand castings, forgings, or fabrications. These parts were converted to centrifugal castings because of actual failures or poor results from the original design or in an attempt to lower costs.

It has usually been difficult if not impossible for the centrifugal producer to effect a change of design to suit his conditions because of the necessity for interchangeable parts or because elaborate tooling would be obsolete. Many parts for newly designed equipment, however, have been designed for the centrifugal process. This technic is being applied to parts in a wide range of alloys both ferrous and nonferrous. It is being used where it is imperative that dense, sound metal structure be obtained on non-forgeable alloys.

Many sand castings which have failed due to difficulties in gating and risering have been successfully converted to centrifugals with a consequent improvement in grain structure and physical properties. In many cases costs have been materially reduced through reductions in finish allowance and higher yield. Yields of 85% are not uncommon and on some castings may go higher.

A list of typical applications for centrifugal castings might include: Bushings, bearings, sleeves, liners; worm gears, gear rims; propellors, impellors; aircraft engine cylinder barrels; landing gear axles; brake and clutch drums; cast iron pipes; and a multitude of parts which may be made by the centrifuge method.

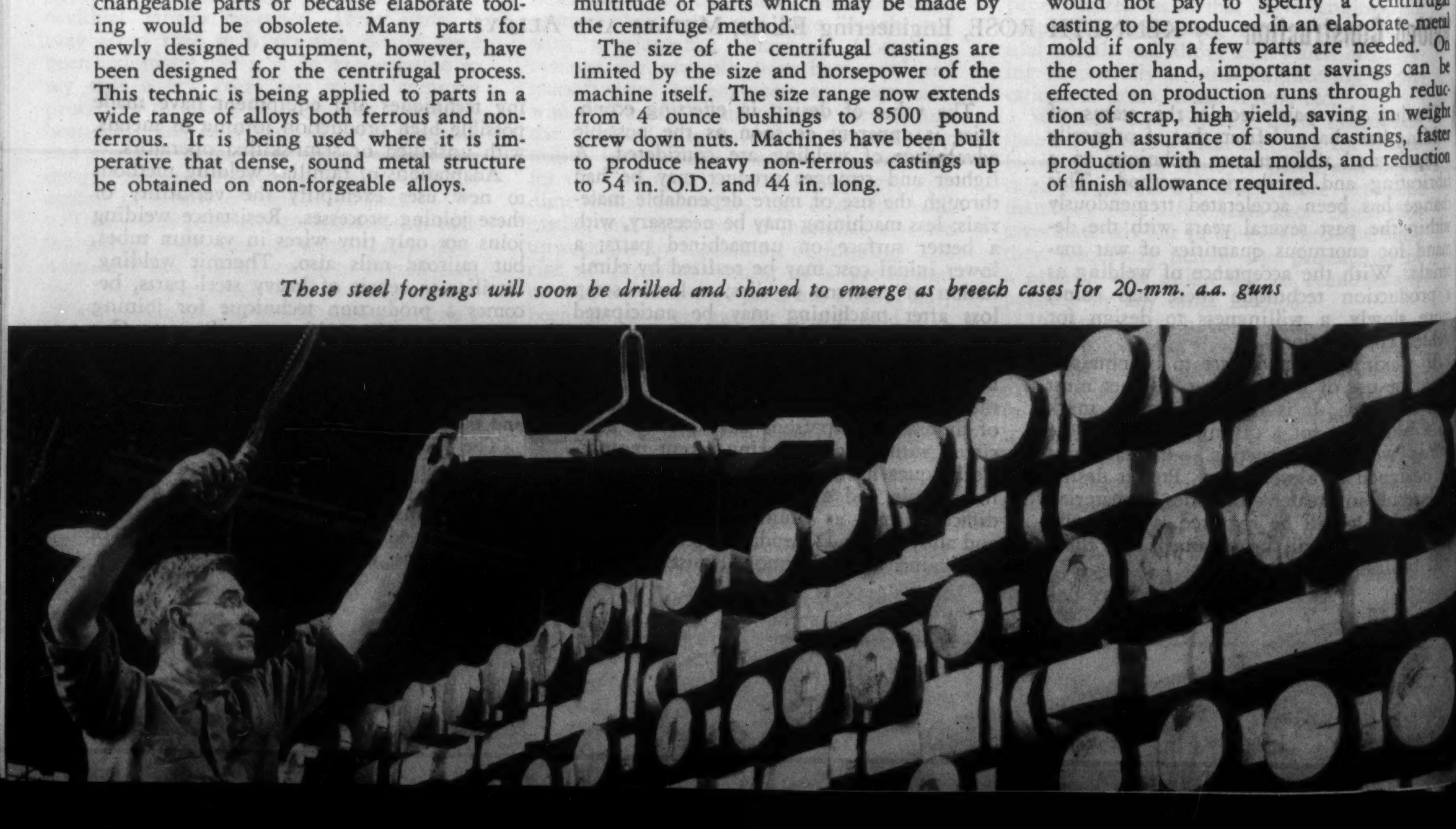
The size of the centrifugal castings are limited by the size and horsepower of the machine itself. The size range now extends from 4 ounce bushings to 8500 pound screw down nuts. Machines have been built to produce heavy non-ferrous castings up to 54 in. O.D. and 44 in. long.

Cast iron pipe can be produced with diameters in excess of 6 feet and lengths of 20 feet. Watertown Arsenal casts 75 mm. gun barrels by this process. The relation of the bore to the length is usually important; however, castings with a length of more than four times the bore are difficult to produce except with special set ups.

In shape, true and semi centrifugals should be symmetrical about their axis and circular. A casting with a flange on one end is easily drawn from the mold, whereas, a casting with flanges at each end cannot be drawn and require split or composite molds.

Experience has shown that it probably would not pay to specify a centrifugal casting to be produced in an elaborate metal mold if only a few parts are needed. On the other hand, important savings can be effected on production runs through reduction of scrap, high yield, saving in weight through assurance of sound castings, faster production with metal molds, and reduction of finish allowance required.

These steel forgings will soon be drilled and shaved to emerge as breech cases for 20-mm. a.a. guns



Plaster Mold Castings by D. K. MOORE, Briggs Mfg. Co., Cleveland

Plaster molds produce castings, in quantity, effecting savings in machinery, simplification of tooling and higher quality, and their use has expanded considerably in recent years. The advantages in savings, tooling and quality are enhanced when the design of the casting, the pattern and the tooling are co-ordinated.

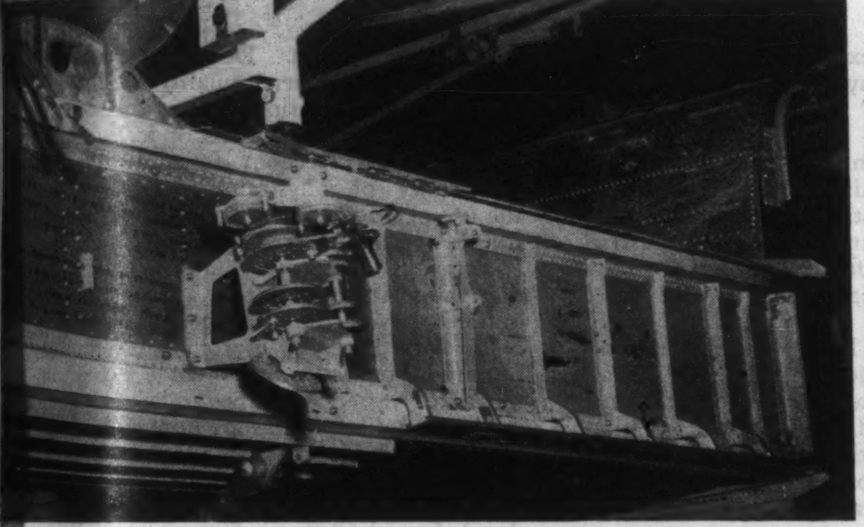
The mold is made in two parts, a cope and drag; this facilitates the use of cores. The standard molding flask has the dimensions of 12 x 18 in. and an over-all depth for combined top and bottom halves of 3½ to 4 in., depending upon the volumetric displacement of the die pattern on the match plate.

The plaster investment is particularly advantageous for the production of copper base alloy castings. Yellow brass produces a minimum of 55,000 p.s.i. ultimate tensile while manganese bronze exceeds 100,000 p.s.i.; the homogeneous grain structure makes brass, bronze and aluminum castings highly desirable for pressure work.

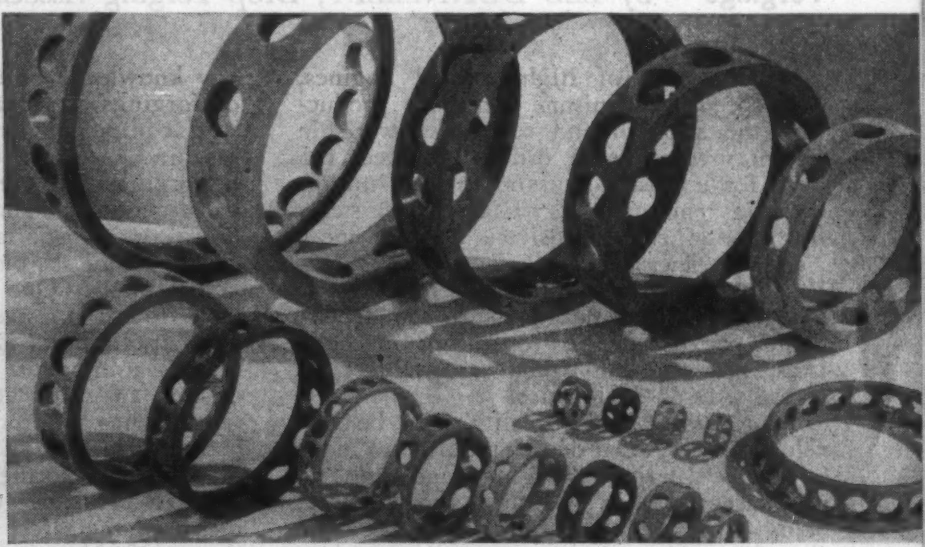
The plaster mold produces high quality castings because it has sufficient permeability to provide ready egress for all air and gas in the mold during pouring; it is sufficiently strong to withstand the metal without distortion, until the metal sets, yet sufficiently weak to crush during shrinkage of the casting after solidification, and thus avoids setting up cooling stresses in the casting. The castings have clear reproduction of fine details with unusual dimensional accuracy and a smooth, attractive as-cast surface. Sections are produced as thin as 0.040 in. and held flat to within 0.001 in. in small areas; drawing tolerances of plus-minus 0.010 in. are generally practical, and in some instances plus-minus 0.005 in. The castings are pressure tight without blow holes, sand or oxide inclusions and their resultant losses.

The use of plaster mold castings has effected many savings because the close tolerances maintained eliminated many machine operations and reduced the time and tools required on the remainder. The dimensional accuracy and smooth surfaces simplify tooling problems by providing accurate and constant locating points, thereby eliminating roughing operations. Since machine loss is negligible, production is increased and unit cost reduced.

Leading industrial companies have taken advantage of this process to obtain amounts ranging from a hundred or so to a hundred thousand or more per month. This process offers the post-war manufacturer a high quality, dimensionally accurate non-ferrous casting which will reduce machining, increase production, simplify tooling and facilitate design. The present high production indicates the wide acceptance accorded the process everywhere. Post-war designing will permit engineers to exploit all its advantages through co-ordination of casting design, pattern design and tooling thereby achieving lower unit cost, simplified tooling and improved appearance. Few types of parts have similar potentialities.



A magnesium casting forms the support for this aircraft assembly



These ball-bearing retainers are made of laminated plastics tubing

Precision Castings by A. W. MERRICK, Austenal Laboratories, Inc., New York

Precision casting has attained a prominent position during the war, due in a very large measure to the fact that it solved the problems involved in production of millions of buckets confronting the designers and builders of airplane turbo-superchargers.

This application illustrates some of the outstanding advantages that the precision casting techniques have, that capture the interest of the designing engineer and appeal to the executives concerned with production.

To the designing engineer it offers possibilities in whole, or in part, that did not exist previously:

(1) Alloys with superior properties for the specific applications can be employed in precision casting that could not be fabricated by forging and machining, or if so, only at great cost in time, labor and expensive tool equipment.

(2) The designer is freed from many of the limitations previously imposed by the practical considerations involved in forging, machining and grinding operations. For example, such complications as hollow vanes and air foil sections are more easily possible.

(3) In the preliminary stages of development a great deal of time and cost can be saved because of the inherent features of the process, which from a single metal pattern, permit the production of the necessary number of pieces required for exhaustive tests at a comparatively low die cost and in a short time. Given a metal pattern, sufficient quantities of castings for trial purposes can very often be produced within a couple of weeks and at a comparatively modest tool and die charge.

The successful production and performance of turbo-superchargers has probably, more than anything else, given a renewed stimulus to the development of gas turbines, for power plants, in planes and terrestrial forms of transportation. The application of superchargers to Diesel motors has also been stimulated by this development. Needless to say, the designing engineers in these fields are keenly alive to the possibilities and advantages of precision casting.

It is obvious that the rate of progress in these fields will largely be determined by the advances of metallurgical development and that as rapidly as better alloys are available, designing engineers will utilize them to the fullest extent.

While forging and machining processes may often be satisfactory, the designing engineer will always have to keep in mind the possibilities of economy in time and money that precision casting offers, and in the case of some alloys there is often no alternative to precision casting.

Because of the war, the principal developments have been confined entirely to gas turbine applications in the plants of the principal producers of precision castings. The interest aroused in other fields, in spite of the little attention it has been possible to give them, indicates numerous applications in the post-war future, not the smallest of which may be the method for making complicated precision dies and other tools.

Stampings and Pressed Metal

by CARTER C. HIGGINS, Worcester Pressed Steel Co., Worcester, Mass.

It was natural for design engineers, trained in small military needs, to call for machined components instead of parts that could be put into presses making 1000 strokes or more per hour. But today—and tomorrow—every design or production engineer should now consider stampings for new products, for individual items, for subassemblies, and for complete assemblies, too.

Although stamping is essentially a mass production technique, recently developed methods of tooling have made runs of even 1000 pieces practical. We used to think of stampings in connection with light, uniform sections; now stampings using ½ in. stock are common. The variations in thickness made possible by ironing and coining make practical new complicated shapes to close tolerances. The question is simply: when does it become more economical to machine?

Formerly, stamping tolerances of 1/64 in. were considered good practise, but tolerances of 0.002 in. and even 0.0005 in. are being met successfully today. A new field of low tolerances, developed by all-out effort, is available for peace-time production.

More odd shapes have always been drawn than most design engineers realized. Stampings with sharp folds, small radii, reverse curves, etc., have lately been widely produced. The war has also spotlighted more efficient use of a greater variety of metals and alloys. Almost any material can be stamped by an experienced engineer, and steels with up to 0.40% carbon are being successfully drawn. In addition to former use of brass, zinc, and steel, stampers have gained much knowledge of aluminum alloys, stainless steels, and some are even working with magnesium.

The fields in which stamping is the most economical means of fabrication have been so greatly increased that almost every established principle of production now has exceptions. The more alert design engineers are telling reliable stamping companies about the functional and dimensional limitations of their production. Metal gages, where the metal will come from on an extrusion, direction of tool impact, tolerances, quantities to be supplied, and other important points are considered.

The opportunities for savings through the use of quick acting presses and new technique are so great that such consultation and training has taken on new importance. American industry looks forward to tremendous production at low cost despite increased labor rates. Against this background of thinking and planning, the future of stampings is bright. A large variety of presses and knowledge is available in job stamping plants for any company, and the only investment required is for the necessary tools. Stampings will continue their forward march into the post-war period.

Forgings

by LEE DONNELLEY, Drop Forging Association, Cleveland

In this day of high-powered engines, high-speed mechanisms, and mass production the strength and toughness available in forgings is being utilized to meet the need for utmost safety and to meet unpredictable emergencies. High-grade steels have long been extensively used to meet rigid service requirements wherever reliability and strength have been necessary to safety of life and to assure the dependable performance of operating mechanisms, the parts of which are subject to severe stresses during use.

In forgings metal quality may be developed to the exact degree required to meet a specific service condition, and due to this fact, forgings of various metals are being more widely accepted and used in aircraft, marine equipment, transportation equipment, Army and Navy ordnance, and for a wide range of industrial and contractor's equipment. Indeed, hundreds of manufacturers who never before the war had any knowledge or experience with the use of forgings are today applying forgings in war equipment or some other essential machine.

Forgings are even now being used for construction and maintenance of fluid handling or transportation systems in refineries, chemical plants, mines, industrial power plants. One field in which forgings have found an ever-increasing acceptance and application is the manufacture of marine equipment. Due to the mass production of ships and marine craft of all types, it has been practical for the first time to invest in dies and use forgings for hundreds of parts formerly fabricated by another method. This use of forgings has greatly increased the safety and effectiveness of all classes of ships.

Hundreds of parts that were once regarded as "impossible to forge" designs are now being forged due to the resourcefulness of forging engineers in utilizing known forging techniques. Designing engineers who utilize the metal quality of forgings find relief from various restrictions because the strength and toughness of forgings and their unusual freedom from defects and uniformity of physical structure permits the use of a lower factor of safety in designing, hence lighter weight sections.

Forgings made with closed impression dies range in weight from a fraction of an ounce to several hundred pounds (one part being forged weighs approximately thirteen hundred pounds), and include an almost unlimited variety of shapes and sizes. Closed impression die forgings are now being made of all forgeable metals, but hundreds of different shapes or parts are forged from carbon, alloys and stainless steel to one that is forged from non-ferrous metal. However, the forging of non-ferrous metals is steadily expanding, with some of the greatest advances in size and applications in aluminum and magnesium forgings.

Coated Metals and Coatings

by K. G. COMPTON, Bell Telephone Laboratories, New York

Two outstanding developments in metal coatings resulting from the war have been the widespread and increasing use of lead as a protective coating on steel and the use of electroplated metal coatings on aluminum.

The lead coatings have been developed as a substitute for those of zinc owing to the war shortages of the latter. The metallic coatings on aluminum are not employed for protection from corrosion (anodic oxides are superior in this respect) but for the purpose of providing low contact resistance, high surface conductivity and better mechanical wear. They are also used to facilitate soldering on aluminum. In most cases these coatings are applied to components of electronic equipment where weight is an important consideration.

Lead coatings have found their greatest use on outdoor hardware and are applied by a hot dip process similar to galvanizing. Recently electrodeposition has been employed for thin coatings on hardware for indoor use. Improvements have been made in the plating baths and several companies have placed the plating chemicals on the market. The corrosion resistance of the coatings has been found to be quite good in most atmospheres and less trouble experienced from porosity than was expected.

The coatings applied to aluminum vary depending on the use, and in most cases consist of combinations of materials. Gold and silver outer coatings are used where low contact resistance or high surface conductivity is required. Nickel and chromium have been employed to improve the wear resistance and tin or cadmium to facilitate soldering.

Plating on aluminum has been described in the literature for many years, but only recently has the process become practical and the adherence of the coating adequate for industrial exploitation. Two principle methods are in current use, one which requires preliminary "anodizing" operation and another which employs immersion in a sodium zincate solution. In both cases it is customary to build up a base coat of copper or nickel as a support for the surface coating.

The adherence of these coatings has been found to exceed the tensile strength of lead-tin solder when two plated specimens are soldered together. The corrosion resistance of the combination depends upon the thickness of the coatings and also upon the particular combination. The cadmium or tin outer coatings have been found to be much superior in this respect. The chemicals for these processes have been placed on the market by several concerns handling plating and cleaning materials.

Cold-Headed Parts

by E. F. KARNES, John Hassall, Inc., Brooklyn, N. Y.

Cold-heading, or cold-upsetting, has been increasingly used in the past year in the manufacture of rivets, bolt blanks and a variety of parts having heads, collars, shoulders or extrusions. The process employs coiled wire which enters the machine through a straightening device and is subsequently cut automatically to proper size blank. On double-blow, solid-die machines, the blank is carried over, inserted into the die and the head or collar is formed by two blows. In addition to forming the head or collar, extrusions or shoulders are formed in the die at the same time.

The first, or gathering blow, forms a cone and the second or finishing blow forms the final shape. The first, or coning blow, is extremely important as the final upset is dependent on proper coning. Further enlargement of the headed portion, after annealing, may be realized by reheading. Reheading, however, is done separately as a secondary operation on especially designed machines for this purpose.

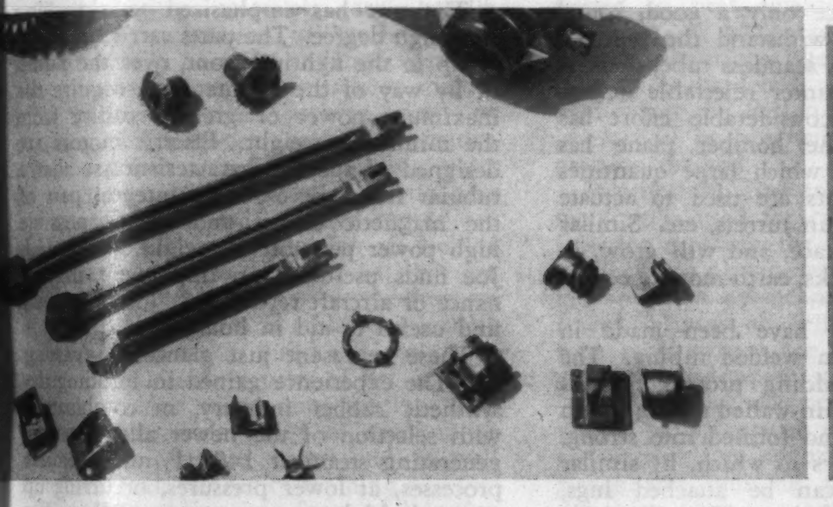
Cold-heading has been found to be economical due to high speed operation and minimum scrap loss and rarely yields to the screw machine. It is the only available means of producing square or hexagon shoulders and tenons without employing expensive, and sometimes prohibitively so, milling operations. See illustrations.

In designing cold-headed parts engineers are learning to understand the limitations of this method. First consideration should be given to the material from which it is to be made. Generally speaking, most of the metals currently in use may be cold-headed. The list includes both low and high carbon steel of cold-heading grades, stainless steel of the straight chrome and nickel-chrome alloys, copper and copper alloys. Brass is available in good heading quality and is used extensively by manufacturers of cold-headed parts. High brass, however, does not lend itself well to extrusion. Brass of high copper content or bronze is preferable, and, when greater strength is necessary, the silicon-bronze alloys may be used.

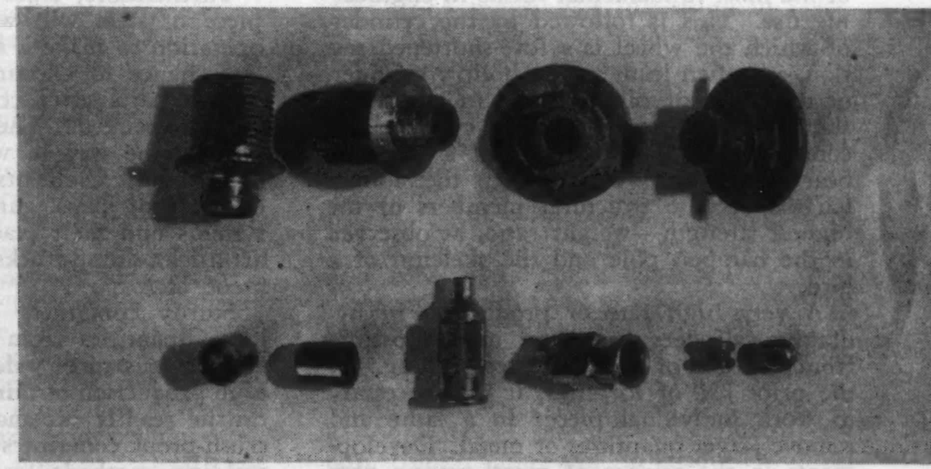
The second consideration in the design of cold-headed parts should be given to physical limitations. Generally, the head or collar should be limited in volume to four times the diameter of wire used, but, this rule is flexible as some metals do not respond because of physical characteristics. This problem may be solved easily by drawing on the everyday experience of manufacturers of cold-headed parts. When large upsets are required, specify the largest shank diameter that will meet requirements as heads and collars are always proportionate to the shank diameter.

When possible, the size of drilled or cast holes should not be specified until the dimensions of the headed part are determined. This may eliminate the necessity for re-drilling holes, or, re-designing a more expensive component. In either case additional expense is involved.

The art of cold-heading is progressing continually and the manufacturer of cold-headed parts should be consulted often to profit by this better, less expensive method.



A range of sizes and intricate shapes are available as plaster-mold castings



Zinc alloy die castings can now be made in tiny sizes, as this actual-size photo shows

Powder Metallurgy Parts

by R. P. SEELIG, Powder Metallurgy Corp., Long Island City, N. Y.

The powder metallurgy industry is composed of a number of fields which are widely diversified and have in common these basic features:

(1) The use of metal powders as major raw material.

(2) The use of pressure as a means of transforming the powder into a more or less solid mass.

(3) The use of heat in order to produce a metallic bond between the particles.

Beyond this, the various branches of powder metallurgy often have very little in common so far as raw materials, methods of handling, technique of processing and resulting properties are concerned.

An outstanding new development has recently been commercialized in the form of aluminum oil-less bearings. These bearings are said to have load capacities equal to bronze bearings. The main advantages are a reduction in weight by over two-thirds and elimination of electrolytic action which might result from an assembly of a bronze bushing in an aluminum structure.

The development of magnetic pole piece materials for applications in indicating instruments, small motors and many other types of electrical assemblies is another modern accomplishment of powder metallurgy. The desirable properties of pure iron can now be approached by a new powder metallurgy technique.

The permeability values of pole pieces made from iron powder are not too far below those of wrought ingot iron and the coercive force is not much greater. Thus, this material can be used where it is desirable to form iron parts which would ordinarily require machining operations and where economies inherent in the powder metallurgy process can be used to good advantage.

Concerning machine parts, the trend is toward development of higher physical properties, especially better shock resistance and increased variety of shapes which can be handled. During the present war emergency, sintered machine parts helped break bottlenecks on many production lines. It was necessary, therefore, to concentrate efforts on development of production techniques and to standardize on materials already established.

It can be anticipated that entirely new materials will enter the dense powder metallurgy part field, yielding special characteristics for particular applications. Missionary work is constantly under way in order to bring before the design engineers everywhere the advantages which can be gained by the use of powder metallurgy for many parts and products in the future. This missionary work is today generally characterized by a notable restraint and a desire to see powder metallurgy parts used *in the right places* and not just anywhere that over-enthusiasm might take them.

In other powder metallurgy specialty fields, such as brazing materials, friction facings, magnetic cores, contacts and cutting tools, research is currently going on in all major manufacturers' laboratories with two aims in mind: (1) To improve present war products; and (2) to develop new materials and applications especially in preparation for post-war requirements.

Screw Machine Products

by W. G. NORD, U. S. Automatic Corp., Amherst, Ohio

During the past few months considerable space has been devoted to the future of the screw machine products industry and for the most part a rather gloomy picture has been painted.

We must frankly admit that many of the parts that were previously made, and for that matter are now being made, on screw machines may be produced more economically as forgings, stampings, castings, die castings, molded plastics, etc.—especially where large quantities are involved so that the cost of molds or dies are readily absorbed. Where quantities are smaller considerable advantage runs to screw machine parts due to the low initial cost.

To counteract the threat to the use of screw machine products there have been developed more efficient automatic screw machines, freer cutting metals and perhaps fully as important as either of the above, new and greatly improved cutting tools. On the other hand, the tremendous developments in molded plastic in the more recent years have more than offset the progress made in the manufacture of screw machine products. In many cases it is impossible to compete with plastics where the strength or wearing qualities of the part is not an important factor, but where it is an important factor, there is for the most part no satisfactory substitute for screw machine products economically manufactured.

Any of the vast array of metal alloys in bar stock form and of high tensile strength or wearing qualities can be machined to accurate dimensions at surprisingly low costs. Where good wearing surfaces are required, the machined parts can be hardened and ground to extremely close tolerances and with highly polished surfaces so that the life of the part can be greatly increased.

In recent years there has become available a great many new types of steel, copper and aluminum alloys that can be quite freely machined, heat treated and ground to make parts that could not be produced by any other method than machining.

There are no doubt many parts now being made on screw machines that will soon be made cheaper by other methods but there are developing great fields for metal parts that require minimum weight and space, maximum strength and better wearing qualities. The continued development of the combination of cast, molded, pressed and stamped parts, together with screw machine products will make cheaper and better equipment available to more people.

Tubing and Tubular Parts

by J. J. B. RUTHERFORD, Babcock & Wilcox Tube Co., Beaver Falls, Pa.

The sphere, because it is isotropic, is one of the most fundamental forms in engineering use. This is followed by the cylinder, of which the wheel is a fore-shortened section, and then leads to the hollow cylinder, or tube, so extensively found in nature. A short section of the hollow cylinder becomes a ring, a tire instead of a wheel, a bearing raceway, a bushing; the longer lengths become structural members of the highest strength—weight ratio, as observed in the bamboo pole and the skeleton of a bird.

A very high rate of production in hydraulic cylinders has been made possible from the use of seamless steel tubing. In the prior use of forgings, it was necessary to work individual pieces in a lathe and remove larger quantities of metal. Developments in the science of metal-cutting now permit the metal to be heat-treated to high mechanical strength before machining so that the cylinder when machined and honed may be immediately available for service of a rugged character.

Furthermore, since only a good, sound piece of steel will withstand the piercing operation to make a seamless tube, there is less chance to encounter rejectable defects in the parts after considerable effort has been expended. The bomber plane has pointed the way in which large quantities of hydraulic elements are used to actuate doors, wing flaps, gun turrets, etc. Similar systems find their place, and will grow, in lift-trucks, dump-trucks, earth-moving equipment, etc.

Sturdy containers have been made in large quantities from welded tubing. The electric-resistance welding process permits high production of thin-walled tubing which can be readily cut and formed into strong, crush-proof containers to which, by similar welding methods, can be attached lugs, shoulders and other fittings. The tube made from cold rolled strip has an excellent surface and after degreasing, may be readily protected by the new plastics being developed so rapidly.

The war has emphasized weight-saving to a high degree. The parts carried manually up to the fighting front, over the hump or by way of the Burma road, require the maximum power or greatest utility from the minimum weight. Electric motors are designed of special characteristics so that a tubular frame becomes an integral part of the magnetic circuit and makes possible high power per unit of weight. What G.I. Joe finds useful as an implement in ordnance or aircraft repair, G.I. Josephine will find useful to aid in housework.

These represent just glances in passing by. The experience gained in building the synthetic rubber industry, in combination with selection of the newer alloys, permit generating steam at 1400 F, and chemical processes, at lower pressures, occurring up to much higher temperatures. What once was oil refining is fast becoming organic-chemicals synthesis, and tubing permits the flow to and through each complex process.

Brazed Assemblies

by R. P. GRIFFENHAGEN & R. A. LUBKER, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

The use of brazing and brazed assemblies in Ordnance and other war equipment has saved much time, machining and large amounts of critical materials, in addition to permitting the economical production of certain very intricate designs. Considerable use is made of the brazed joints in the electrical industry because of the necessity for strong connections with high electrical conductivity.

The methods used include torch, resistance, induction, and furnace brazing. "Phos-Copper" is used for low temperature brazing of copper and copper alloys, silver-base brazing alloys are used for low temperature brazing of ferrous materials, brazing spelter (50% Cu - 50% Zn) is used for high temperature brazing of copper and copper alloys, and copper is used for the furnace brazing of steel.

"Phos-Copper" is generally used for copper-to-copper joints because it provides a reliable joint at low cost without the need for a flux which may cause corrosion and insulation failure. Brazing of coil leads to the commutators of D.C. armatures is a typical example. The desired amount of brazing alloy is preplaced on the riser by spot-welding before construction of the commutator. After assembly of the coils, the risers are bent aside and the lead-to-riser joints are brazed between the jaws of a carbon-block machine. Adjacent insulation is cooled with a jet of compressed air to prevent burning.

By taking advantage of its ability to join a wide variety of metals of varying section sizes and shapes without distortion and oxidation, the use of brazing has permitted manufacture of many uniquely designed assemblies, usually at low cost and high production rate. Reliability from the standpoint of high strength and freedom from leaks is another factor in its use. Furnace brazing particularly is therefore becoming of increased importance in the fabrication of sheet metal parts, screw machine parts, and many intricate assemblies.

The copper brazing of steel parts has received the greatest emphasis in this field but there are many applications involving the joining of non-ferrous metals. The usual types of brazing alloys are employed and flux must be used except when brazing copper-to-copper with "Phos-Copper." When brazing tough pitch copper, precautions must be taken to avoid embrittlement by the reducing atmosphere.

Many thousand air-tight bronze to brass joints on condenser bushing flange assemblies have been made by brazing with resulting quality improvement and cost reduction. Incidentally, the bronze castings must be of high quality to resist absorption of the brazing alloy if the latter is "Phos-Copper."

Plastics Castings

by W. R. THOMPSON, Catalin Corp. of America, Fords, N. J.

One of the fastest growing applications of cast thermosetting resins (and one that is of especial interest to the metal-working engineer) is their use for "soft" tools for forming purposes. During the year 1944 plastics tooling has continued in popularity, earning a permanent place in modern production. Performance tests have corrected early misgivings and its use in industry has been established on a sound practical basis, especially in the production of aircraft, where cast resin tools have provided speed, low cost and flexibility.

By virtue of their physical properties the cast thermosetting phenolic resins have been used successfully as forming dies, stretch press dies, drill jigs, checking fixtures, assembly fixtures, spot welding and torch welding fixtures, etc. not to mention a host of miscellaneous items. No other type of plastic has been adapted to such a wide range of tooling applications.

It is the practice to cast the plastic tools and parts in wood, plaster, or metal molds which have been coated with a special lacquer to insure easy removal. The viscous honey colored resin is heated to 70 C and is poured into the heated molds to be cured in an oven to the proper hardness. Where physical properties are not too important various fillers such as walnut shell flour, mineralite, asbestos, ground pre-set plastic, etc. may be added with a considerable saving in raw material cost.

For a "permanent" tool having the maximum tensile, flexural, and compressive strengths coupled with good aging properties, it is generally recognized that the best results are obtained by curing the unfilled resin at a temperature of 75-80 C for 72-96 hrs. Practically speaking there is no limit to the size of the casting provided adequate equipment is available.

Cast phenolic resins are also available for use with an accelerator to shorten the time of cure to a cycle not exceeding 12 hrs. These products have proved particularly useful for rush on "temporary" tools.

The happy combination of cast resins in plaster molds is a life saver for the designer, tool engineer, and a host of others whose primary consideration is time. Tools may be cast in a plaster mold or to a master part, more quickly than by conventional forming, milling or hand fitting operations. Furthermore, there is not only a saving of critical war materials but costs are reduced on the assembly line where these new tools are used. Finally, there is the added flexibility which the present day demands through its frequent change in design—an important factor in both the war and reconversion periods.

Compression and Injection Molded Plastics

by CHARLES PRINCE, Bakelite Corp., New York

Thermosetting materials are usually molded by compression in hand-operated, semi-automatic, or fully automatic presses. There are four types of compression molds: fully positive, landed positive, flash or overflow, and semi-positive. Fully positive molds are best suited for molding parts in which maximum density and toughness are required. Landed positive molds are used when greater uniformity of molded height and thickness are required; they are suited for a wide range of medium to deep-drawn parts. Flash molds are usually the least expensive to build and are generally used for molding parts of flat or shallow construction. The semi-positive mold is used for a wide range of medium to deep-drawn industrial parts, and is well suited for multiple cavity molding.

Transfer molding is a form of injection molding applied to thermosetting materials. In this method, the material is plasticized by heat outside the mold proper and then, as a hot plastic, is transferred through an orifice into a hot mold where it is set or hardened. Transfer molding is used when the design of a part makes it impractical or impossible to use the compression method.

Injection molding as well as compression molding is used for cold-set materials. In injection molding, the material is heated to a sufficiently plastic state in a heating chamber and then by means of a plunger, it is forced through an orifice into a relatively cold mold where the molding is formed and hardened upon cooling.

In designing thermosetting and thermoplastic parts, certain principles of design are dictated by sound engineering experience and molding practice. Details of designing principles are too complex to be discussed in a short article. Certain trends in shape, size and application are worthy of note, however, and are outlined below.

Injection molding is increasing in favor as a rapid, automatic production method for thermoplastic parts. Transfer molding of thermosetting materials is also gaining in popularity because of the greater design intricacy that is possible, the closer tolerances frequently obtained, and the utility of the method for heavy cloth-filled materials and melamine-formaldehyde compounds.

Maximum sizes of moldings and production speeds have been advanced by press design and by the use of the new electronic preheating technique; parts weighing up to 10-15 lbs. are not uncommon. Intelligent mold design often permits greater variation in wall thickness than was once possible. Mechanical and thermal properties of certain compression and injection moldings are better, too, because of the development of improved materials. There will be gradually increasing use of molded plastics.

Laminates

by R. L. FOOTE, Synthane Corp., Oaks, Pa.

The plastics industry is a youngster, only about 75 years old. Many of its materials are even younger and—in many ways it's unfortunate—these are the materials that have caught the public fancy. These plain truths only serve to support the fact that plastics usages after the war will have to be "enginomical" (technically sound, with due attention to cost factors) just as they always have, in order for the industry to exist.

Broadly speaking, laminated plastics is one of the older phases of the industry. It only remains, therefore, to consider some of the new materials and methods that recent months have placed at the disposal of the laminating industry as new tools for the designer to use. If the resulting "enginomics" is good, laminates will be more broadly used.

At a very modest sacrifice in physical properties, it is now possible to mold laminated shapes at pressures of 150 p.s.i. or less, instead of the formerly necessary 1500 p.s.i. or more.

This changes the entire economic picture surrounding mold construction and, in turn, permits the designer to consider laminates for non-structural or moderately stressed housing, guards, etc. where tooling costs would, formerly, have upset his "enginomics."

It is now possible to form cured laminated phenolics. This process, known popularly as "post forming," should be thought of as an added fabricating technique. To the designer it means that he need no longer confine a laminated piece to the single plane of a flat sheet. Rather, his laminated phenolic materials take on some of the design flexibility that forming adds to sheet metal.

New base or filler materials, such as glass textiles, present the possibility of laminates with tensiles of 50,000 to 100,000 or more p.s.i. at specific gravities of 1.5 to 1.9. Strength for weight, this outranks the best steels. At present, these materials are expensive but some applications already show favorable "enginomics." More are sure to follow as designers become familiar with these materials.

Laminates with better high frequency dielectric properties are here and further improvement is in sight. The "enginomic" future of a machinable material that will compete with ceramics from this angle is assured.

These are a few of the more recent developments, stated broadly, which make the laminator feel that his materials are certain to have a broader participation in the post-war picture than they had pre-war. The extent of this increased usage depends upon the engineer's and designer's interest in seeking and the laminator's ability to find, those usages that are good "enginomics" and that are sound application-engineering.

Materials for Solving

SPECIFIC ENGINEERING-SERVICE PROBLEMS

Following a comprehensive survey by J. F. Young of recent broad trends in design engineering, this section presents several brief reviews of progress in applying materials to the solution of specific engineering-service design problems.

Design Engineering and Material Selection

by J. F. YOUNG, General Electric Co., Bridgeport, Conn.

The criteria for selecting material for a particular design application are suitability to the purpose, availability, and maximum economy. All are interrelated. A suitable material must possess properties meeting the service requirements and also such properties as will accommodate and properly react to the preferred method of processing. Availability influences selection through cost extras and time premiums on favored materials and through the facilities, e.g., skilled workmen and equipment, that can be utilized for manufacture of the total quantity anticipated. Maximum economy is then approximated by dimensioning and detailing the design to provide for the properties of the suitable and available materials and for the characteristics of the available processes while obtaining proper functioning, quality, and appearance.

War-time production has obviously shifted the emphasis from economy to suitability and has played havoc with availability. Material shortages, manpower shortages, necessity for short-time delivery, and demand for high productivity have all affected designs appreciably. Engineers have found themselves getting away from old traditions and standbys, and, in many instances, improving performance or securing other unforseen advantages. Some new-found material-design compromises are sure to stay; others to promote a renewed approach to the design of peace-time products.

That former material-design precedents are no longer secure is further assured by the developments in materials research and by the expansion of facilities for refining and processing materials. No product should automatically be designed into the same material and form after the war as before. The anticipated competition among producers will make available materials and production methods having properties, tolerances, forms, and relative prices more attractive generally than those of a half dozen years ago, and maximum economy will be obtained only through their effective utilization.

Whereas this trend in emphasis has been clearly evident, the trend relating to the properties of materials has not been so pronounced. Our knowledge of materials has nevertheless been greatly augmented during the war period. Most significant, perhaps, have been (1) the determination of properties for service conditions not formerly explored to any great degree, and (2) a general stimulus to the study and interpretation of property tests with consequent reduction in the number of necessary simulated service tests of complete machines or of parts.

Some of the service conditions for which new data on material behavior have been determined (but generally not published) are static and impact loads at low temperature, medium- and high-speed shock at normal temperatures, static and fatigue strength at greatly elevated temperatures, and loads producing triaxial stresses of various kinds.

Space prevents review of developments on the utilization and interpretation of properties, but perhaps a few highlights will illustrate the trend.

1. In aircraft design the minimizing of excess weight has led to wide use of strain gages, calibrated brittle lacquers, and sensitive extensometers to determine service loading and, in that way, to facilitate either design of parts or formulation of simulated service tests. These methods together with photoelastic studies and extensive use of analytical methods have enabled more accurate determination of service stresses—the basis for utilization of strength properties. More attention is needed, however, on the determination of stresses introduced and retained with various processes.

2. Variations in properties from heat to heat, particularly of alloy steels, have promoted interest in property probability curves. Such curves are needed for relating tests of single models to the performance that may be expected from production.

3. Ordnance requirements have resulted in much progress in protecting parts from severely corrosive environments, in packing parts to withstand handling and shipment, and in wide use of standard specifications and test procedures.

4. Broader engineering understanding and appreciation of standard property tests has been achieved. Typical examples of improvements in interpretation of tests are the use of hardness measurements and notched-bar impact tests mainly for quality and uniformity comparisons, the recognition of importance of local ductility rather than general ductility in fatigue and forming, and appreciation of size effect in comparing properties of parts, such as large castings and forgings, with those of test bars.

In summary, these recent advances should result in a more careful and more effective utilization of materials. The day of choosing a material and preparing a specification from a handbook after the design is finished is fast disappearing. Future material selection should be a matter of careful study, by the designer in cooperation with the materials engineer or metallurgist, for only in that way can the compromise between material and process be made so as to fully *exploit* the special properties and characteristics of each, and still compensate for the limiting properties of materials by suitable engineering design.

High Temperature Materials and Design

by N. L. MOCHEL, Westinghouse Electric & Mfg. Co., Philadelphia

Some few years ago, many of the problems involved in maintaining tight high-pressure, high-temperature steam joints were solved by the elimination of such bolted joints, whenever possible, and welding the necessary joints together. But as often happens, one solution brings other problems, and this is what we have now experienced in the matter of graphitization of carbon-molybdenum steel steam piping in central station operation. Carbon has separated itself as graphite, in varying degrees and conditions, especially adjacent to the welds, in a number of places.

There has been much investigation, thought and discussion of graphitization of this type during the past two years. It is the No. 1 high-temperature matter before us today. Those directly interested are familiar with the very real progress that has been made, as reported at a meeting of the American Society of Mechanical Engineers, on December 1.

The method of manufacture of the steel and the resulting structure offer one possible solution to the matter. The addition of a small amount of a more stable carbide forming element, such as chromium, would appear to be a logical approach. The most controllable solution to the problem is the one that should be the goal of these studies.

This experience has directed attention to the need for more critical examination as to the stability of materials, and their condition as actually placed in service, when high temperatures are involved.

The other outstanding high-temperature development of these times is the matter of the gas turbine. Here design and materials are inseparable. We hear and read much of turbo-superchargers, of jet-propulsion of planes, or gas-turbine propeller drives for planes, of gas turbines for locomotives and ships. Do we have materials that will make these practical?

Much of the development of materials for these has been under confidential or restricted arrangements, and only those directly interested have been supplied with the data. It is assumed that, eventually, these data will be given more general release.

Operation at temperatures of 1200 F., of 1500 F., and of parts as high as 1800 F. naturally bring new problems and require new materials. It can be said that for practical purposes and present requirements the materials were evolved, and in time.

One should keep in mind in this development, the fundamental learned at an earlier and lower-temperature period, that allowable stress, temperature, expected life and allowable deformation are inseparable, and must hang together. Stresses (and materials) that can be utilized at these high temperatures for applications of short expected life, such as in war-time applications, must be re-examined when applications demanding long-life become involved.

Low-Temperature Impact Resistant Materials

by J. J. KANTER, Crane Co., Chicago

The application of cold-resistant metals and alloys for large scale operations at very low temperatures is engaging considerable interest among design and materials engineers. Low-temperature developments concerned with chemical process plants, refrigerating plants, aircraft and other equipment exposed to the extreme lows of atmospheric temperatures have stimulated new investigations of low-temperature properties. This interest extends to temperatures of -300 F—a level associated with liquid air.

The property of primary concern in low-temperature inquiries is usually impact resistance. There is little difficulty in finding adequate low-temperature design strength in any of the structural materials—the great difficulty arises over encounter of a temperature, short of the low temperature goal, at which occurs a transition from toughness to easy fracture upon shock.

The ordinary carbon and alloy steels are prone to reach this transition at temperatures from +25 F to -100 F depending upon composition, melting process, heat treatment, etc. In general, a normalizing and quenching treatment fixes this transition at lower levels than do finishing temperatures and annealing treatments. By special attention to alloying, melting process and heat treatment, low-temperature toughness of ferritic steel may be extended to -175 F.

Stainless steels of the austenitic type, for example 18% chromium 8% nickel, may retain great toughness at temperatures as low as -300 F. Such toughness seems to be an attribute of the austenite phase regardless of composition. So long as a steel remains predominantly austenitic and is not transformed to ferrite by being subject to low temperature, it remains impact resistant.

When austenite is unstably retained, however, low temperature may destroy the impact resistance of an otherwise tough steel. Low temperature is now being widely used for the express purpose of dispelling retained austenite from tools and gages. However, when an austenitic steel is selected for a low-temperature structural application necessitating toughness, it should be definitely balanced for austenite stability.

Much interest centers on copper base alloys for extremely low-temperature applications because of their toughness and freedom from embrittling transitions and transformations. A wide variety of brasses, bronzes, and special nonferrous alloys, in both cast and wrought forms have been found to be characterized by good impact resistance at low temperature. Certain copper alloys of the single phase type are particularly outstanding in this regard, and attractive as low temperature constructional materials because of their adaptability to welding methods.

Design and Materials for Corrosion Resistance

by F. L. LAQUE, International Nickel Co., Inc., New York

Design for corrosion resistance involves both the choice of material and its application so that it can perform best. For example, since crevices favor local attack, either they should be eliminated, or sealed, or a material chosen that is least susceptible to crevice corrosion.

A better understanding of the mechanisms of corrosion processes has been a most important contribution to design through the more effective application of experience in the avoidance of new corrosion difficulties.

Designers of salt water condensers are able to limit water velocities to suit the materials to be used and producers of alloys have been able to provide materials like the aluminum brasses and the copper-nickel alloys with a controlled addition of a small percentage of iron to take care of exceptionally severe service conditions.

Principles based on the fundamentals of galvanic corrosion account for the advantageous use of valve trim materials (Monel) more noble than valve bodies (bronze), so that the vital working parts will be protected without serious damage to the bodies. Cathodic protection, either from sacrificial corrosion of zinc or magnesium, or by applied currents, is being utilized on a more scientific basis not only to prolong the life of equipment, but also to reduce contamination by corrosion products.

Proper surface preparation, sometime supplemented by chemical pre-treatment, is recognized as a factor of major importance in protection by organic coatings. Organic coatings are used to repair glass-lined vessels and to protect large steel tanks and tank cars.

Electrodeposits of closely controlled thicknesses of zinc, lead and tin, sometimes supplemented by copper or nickel, have come into increased use. Steel clad with appropriate corrosion resisting metals has become a standard material for heavy chemical equipment. Corrosion resisting linings are applied to fabricated vessels by spot welding, plug welding or strip lining, or in multilayer construction.

Rigid limitations of impurities, surface treatments and finishes and control of stress corrosion by annealing prolong the life of magnesium alloys in corrosive environments.

The new aluminum alloys containing zinc and magnesium have been made equal to the older alloys with respect to susceptibility to stress corrosion cracking, so that advantage can be taken of their superior tensile properties.

The nickel-base molybdenum alloys provide excellent resistance to halogen compounds. A special low-carbon content nickel has been made available for service in contact with caustic soda and other salts at elevated temperatures.

Fatigue Resistance

by FRED P. PETERS, Editor-in-Chief, METALS AND ALLOYS

Wartime progress in the battle against vibration and repeated-stress failure has been remarkable. Progress has included the elimination or reduction of vibration wherever possible, the mechanical improvement of surface strength by pre-stressing, the avoidance of surface discontinuities and the designing of parts to provide suitable fillets and avoid notches or sharp changes in section.

Damping capacity (the ability of a material to absorb and thus "dampen" vibrations rather than to transmit them freely) has been intensively investigated, and certain metals have been shown to possess it to a degree that has invited new engineering respect for them. Foremost among these is the once-lowly gray cast iron, whose damping capacity is so much higher than those of other metals that despite its frequently lower strength and fatigue value it is one of our best engineering metals for vibration service. The increased use of gray cast iron—and especially of the high strength varieties now available—is one way in which alert machine designers reduce vibration and thus cut down the number of fatigue failures that may occur in their equipment.

Cast iron and other materials of high damping capacity tend to eliminate the vibration that leads to fatigue failure. Most attention in the fatigue sphere, however, has been directed to making materials and machine parts more resistant to whatever vibration *does* occur, or to repeated stressing or alternate pulling and pushing of a part. This has involved not so much the development of new fatigue-resistant alloys as the treatment or protection of metal surfaces in various ways, primarily to aid in opposing the formation of even the tiniest fatigue crack.

Thus, in the heat treatment of parts intended for fatigue service controlled atmospheres, salt baths or quick surface hardening methods are employed to avoid (in some cases even to correct for) decarburizing the surface, for a decarburized surface is highly susceptible to the formation of a fatigue crack. Scratches, tool marks, identification markings, and the like are scrupulously avoided in airplane wing coverings, propeller blades, overhead power-line cables, machinery shafts, bearings, etc., for from such small beginnings do great fatigue failures grow. Surfaces of parts are highly polished in proportion to the fatigue service they are expected to undergo; occasionally they are electroplated to improve their endurance, but some types of plating seem to be better than others, while certain electroplates are definitely harmful.

The most spectacular method of improving the fatigue strength of a metal part is shot peening. By this mass-production treatment castings, forgings and machine parts are enabled to resist from two to ten times the number of stress reversals that the unpeened part could withstand, and in addition are surface-cleaned. We are now learning, also, that certain other surface-treating operations—carburizing, flame-hardening, induction hardening, etc.—may have a beneficial effect on fatigue life through the compressive pre-stressing they induce, but also that such treatments if improperly designed or carried out may lead to premature fatigue failure.

Fatigue failures are believed by many engineers to be the most common cause of breakdown of mechanical equipment. Their reduction will obviously mean better and longer service from our machines, but in a broader sense, our new ability to design parts of thinner sections means greater power can be built into machines of given weight than has been possible heretofore.

Wear Resistance—Materials and Design

by R. W. DAYTON, Battelle Memorial Institute, Columbus, Ohio

Wear is not a necessary accompaniment of machine operation, as is demonstrated by the fact that such large machinery as turbines and generators runs for years without appreciable wear of the rubbing surfaces. The reason is obvious—this class of equipment is adequately protected from abrasives and corrodents, the common wear-producing agents. Protection of this type is the surest and most complete method of solving any wear problem.

For example, the most effective solution to the problem of extremely rapid aircraft engine wear in desert operation was air cleaners. Those used greatly reduced the seriousness of the problem—a perfect filter would have been expected to eliminate it completely. In this case, no study of materials could have done a fraction as much good, even with a much greater effort.

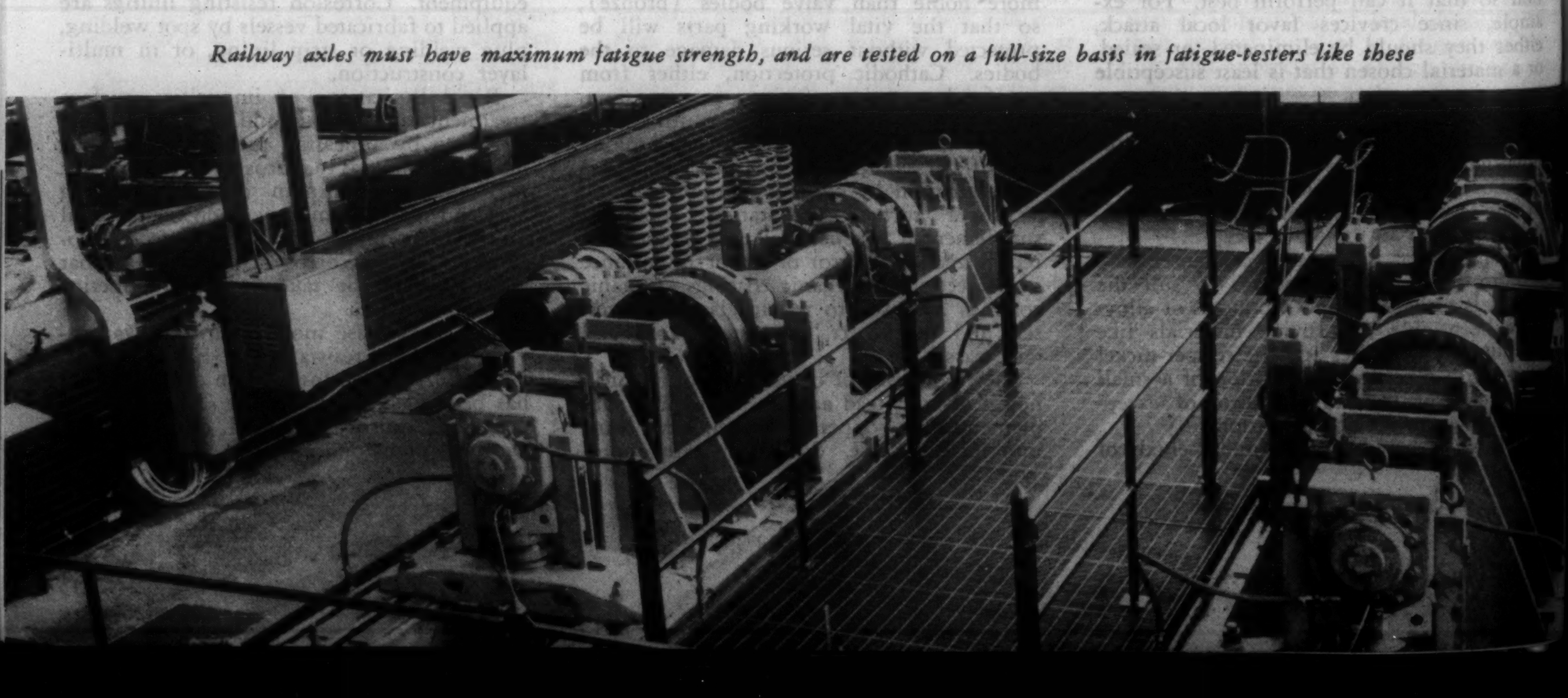
When wear is an unavoidable part of the conditions of service, a reduction of wear can generally be obtained by the selection of suitable materials for the case in point. In this task, one is far less limited than heretofore, because of the recent developments in coatings. Instead of being limited to the comparatively small number of materials which can be fabricated commercially, developments in electroplating, vapor-phase coatings, cladding, surface heat treating, and fused-on coatings are being made so rapidly that soon the designer may be able to choose anything in the periodic table if it's for a wear-resisting surface.

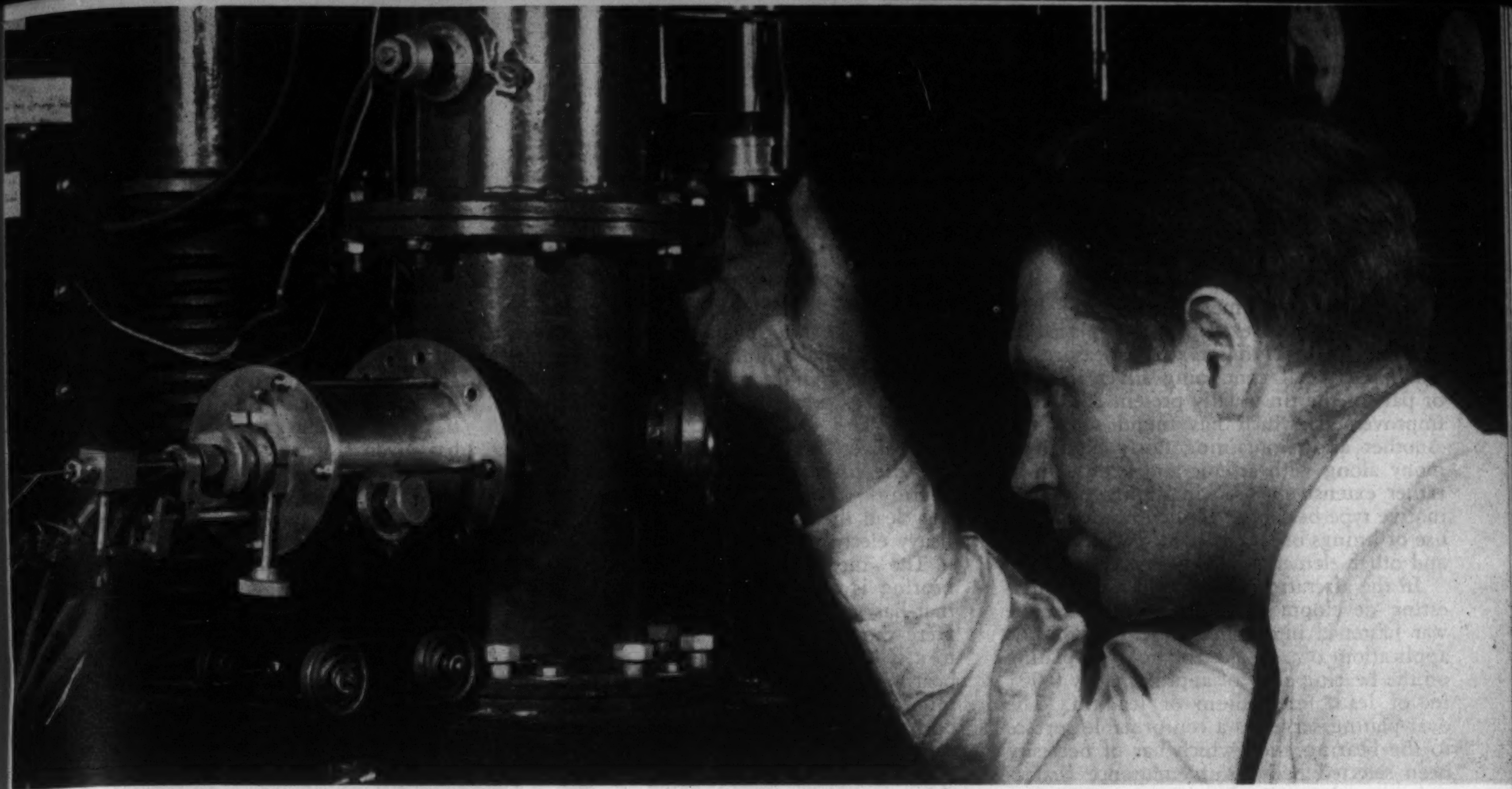
The advantages of electroplating are so considerable—no heating, the availability of thick or thin and even coatings, and a wide choice of materials—that it will probably find the widest application of coating processes. Now that it has been demonstrated that electroplates can adhere with the strength of the materials involved, engineers will begin to appreciate that electroplating is not just a decorative process, but an engineering one as well. That the process has already grown up is demonstrated by the fact that practically all silver bearings, which now are standard in large aircraft engines, are produced by electroplating.

Chromium electroplates appear to be highly versatile. Porous deposits for piston rings and cylinder barrels are performing well, resisting wear and scuffing better than previously used materials. Thin chromium deposits have been found to prolong the life of small tools. These useful properties of chromium plates were considerably anticipated by the use of chromium-plated gages, which considerably outwear hardened steel gages. Much wider use of chromium is anticipated.

Surface-hardening techniques are being developed rapidly and can be expected to be useful for many applications. The other surface-treating methods are not so well developed, or have not yet been as generally successful and will not be discussed here.

Railway axles must have maximum fatigue strength, and are tested on a full-size basis in fatigue-testers like these





More intelligent application of materials in corrosive environments is one of the results of electron-diffraction studies of corrosion coatings on metal

Design for Lightweight Construction

by ELLIS W. TEST, Pullman-Standard Car Mfg. Co., Chicago

A little more than a year ago a high railroad official, answering a trade survey, said, "Every one on this railroad is unreservedly in favor of lightweight equipment for passenger trains. We will never buy another heavyweight car." Results of the survey proved that he was speaking for the entire industry. I believe he also reflected the opinion of other industries using mobile equipment.

Before the war, high-tensile low-alloy steels, aluminum alloys and stainless steel were the three metals employed in producing lightweight railroad cars; the last two, magnesium alloys and to a tiny extent, plywood served in aircraft and other "lightweight" fields. Of these we found that high-tensile low-alloy steel represented an ideal balance between light weight and low cost for passenger cars. It was much cheaper than the others, had twice the strength of ordinary steel, and also was available in all important rolled forms, thus providing a broad selection of structural shapes. Since 1934 we have built more than 1,300 passenger cars of this metal and not a single one has failed or exhibited structural weakness.

Aluminum alloys are reliable structurally, have uniform physical characteristics and will not deteriorate if adequately protected by paint. They suffer in cost comparisons, however. Even if the price of aluminum is halved after the war, as has been hinted, the aluminum car structure will still cost substantially more than the low-alloy steel structure.

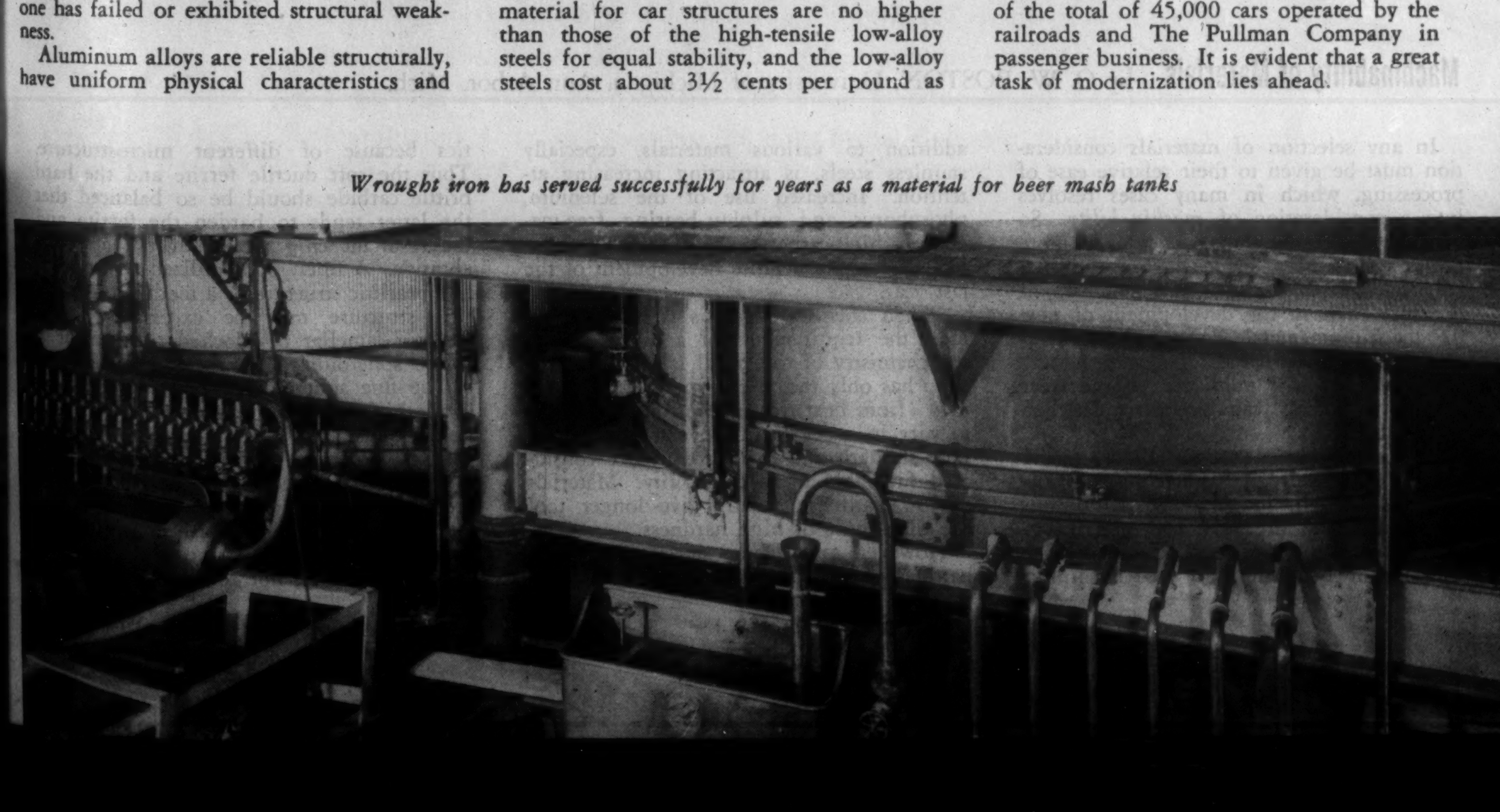
Despite the high cost, however, aluminum does shave as much as 9000 lbs. off the weight of car shells or body structures as compared with low-alloy steel. This is a powerful argument to mountain-climbing roads, to whom weight is vital. The same reasoning doubtless applies to aircraft, where weight, and not cost, is the principal consideration.

Stainless steel has many limitations which make it less desirable than the other two for carbuilding but which do not necessarily operate for aircraft and motor-vehicle use. Its high-tensile properties are not inherent but are induced by the cold rolling process, which frequently sets up certain internal stresses that reduce the added load which can be applied safely. For various reasons, the safe allowable working stresses of this material for car structures are no higher than those of the high-tensile low-alloy steels for equal stability, and the low-alloy steels cost about 3½ cents per pound as against approximately 35 cents for stainless steel.

In investigating the postwar possibilities of other metals which might join this tested trio, we have jointly concluded with the magnesium producers that magnesium offers no structural advantages for cars over the aluminum alloys but is much more expensive. The applications it will find in other fields will result from the fact that, like aluminum, its lightness may be important enough to justify the extra cost. The new high-strength aluminum alloys, easier-to-form wood and plywood structures and ribbing or ridging to increase the rigidity of light-sheet stainless steel are all expected to find important uses in the industries that depend on light weight for profit.

But whether the big three of the prewar era or new materials are employed, it seems certain that lightweight construction will keynote postwar manufacturing of all kinds of mobile equipment. In the railroad industry alone only 2,350 lightweight passenger cars had been built when war halted further production. This is only 5 per cent of the total of 45,000 cars operated by the railroads and The Pullman Company in passenger business. It is evident that a great task of modernization lies ahead.

Wrought iron has served successfully for years as a material for beer mash tanks



Bearing Materials and Design

by E. R. DARBY, Federal-Mogul Corp., Detroit

Tin base lining metals (babbitts) have to a considerable extent been replaced by lead alloys as a conservation measure. A lead base metal containing silver in place of part of the tin usually present is a recent improvement which has found some use. Another alloy containing fairly high antimony along with arsenic and a little tin is rather extensively used in linings for automotive type bearings. In diesel bearings the use of linings of lead hardened with calcium and other elements has become common.

In the aircraft field is found a very interesting development in bearings which the war hastened into general use. This is the application of an electrolytic over-plating on the bearing alloy of approximately 0.001 in. of lead, lead-indium or lead-tin. The over-plating serves as a conformable surface to the bearing alloy which has of necessity been selected because of endurance characteristics rather than bearing properties.

The most noted example of this development is the steel back bearing lined with silver as the intermediate layer and plated with lead and indium on the bearing surface. The indium after diffusion into the lead acts as preventive to corrosion by lubricants. The electrodeposition of the very thick silver lining on the steel back, though not the first development in electroplated bearings, is the most spectacular use and may lead the way to broader application of heavy electroplates in the future.

The metal powder copper-lead lined bearing is one of the recent developments that has gone into high production figures. Here the copper-lead is applied as powder to a steel strip in a continuous fashion and bearings are in reality being made by the mile. The copper-lead may be applied to both sides of the steel strip without difficulty, and thicknesses may be accurately controlled, with only a minimum of machining stock necessary.

Though a pre-war development the aluminum bearing, one piece or on a steel back, is creating considerable talk. With aluminum off the critical metal list, this aluminum-tin alloy may be a contender in the bearing metal field. Its endurance qualities are excellent and as a one piece bearing has given a good account of itself in tests on hard and moderately hard shafts.

Not much of moment can be said about new design in bushings and bearings. The use of thin instead of thick linings seems here to stay. The employment of end relief on aircraft bearings by making room for shaft deflection has helped a lot. Oil grooves on pressure applications are becoming less evident, and the design of connecting rods for use with steel back bronze lined floating bushings has put in appearance. When engines or machines are improved or changed in design frequently a change in bearing material is called for and conversely an improvement in bearing material can permit a change in design that is desirable.

Materials for Special Electrical Purposes

by FRANCES H. CLARK, Western Union Tel. Co., New York

Although the Bell Telephone Laboratories has used endless loops of magnetic tape for sound recording for some years in their weather announcing systems, the advent of the war has brought renewed interest in the problem. The U. S. Army is now using tape for recording "on the spot" developments. The records need not be processed but can be played back immediately.

A successful magnetic alloy for this application is "Vicalloy" containing 6-16% vanadium, 30-52% iron, 36-62% cobalt. This alloy holds more permanent magnetism than any other commercial material and, moreover, can be rolled and drawn into a thin flexible tape. A special heat treatment is required to develop suitable magnetic properties.

Just before the outbreak of the war, the Philips Company of Holland announced the development of a new permanent magnet material, now called Alnico No. 5, which had remarkable properties in that, under suitable heat treatment, the residual induction was nearly double that of any Alnico previously made. This alloy has had many applications for ordnance equipment. Its composition is approximately 8% aluminum, 14% nickel, 24% cobalt, 3% copper, 51% iron. A special heat treatment is required to bring out the maximum magnetic properties, which consists in heating to 2420 F, and cooling in a magnetic field of 1000 H (oersteds).

With the formation of A.S.T.M. Committee B-9 on powder metallurgy products, the question has arisen concerning the comparative magnetic properties of pole pieces made from metal powders with those from soft ingot iron. A high purity electrolytic iron powder is required as a raw material for pole pieces if magnetic properties must be in the class of soft ingot iron. Machining costs for the peculiar shape of the pole piece must be fairly high to make the use of powder metallurgy parts economical. If it is found that slight impurities (say the very small amounts of nickel) in ingot iron have a deleterious effect on the magnetic properties of the product, this may increase the trend toward the use of pole pieces made from iron powder.

A noticeable change in materials suitable for electrical contacts has been the tendency to substitute noble metals for some of the alloys formerly used. As an example, metals of the platinum group are finding wider use due to their low electrical resistivity and their high resistance to oxidation. This trend has also been observed in the extended use of silver alloys to replace copper alloys.

A remarkable record has been made by the silver-cadmium oxide series of alloys and their excellent life under service conditions gives great promise for their future.

It is interesting that clad materials on copper and ferrous metal bases have been found economical for electrical contacts. There has also been an increased demand for improved design regarding the shape of contacts.

War in the tropics has posed serious problems in regard to climate so that demands have been made for contacts with high corrosion resistance while operating under high humidity and temperatures.

Machinability of Materials

by O. W. BOSTON, University of Michigan, Ann Arbor, Mich.

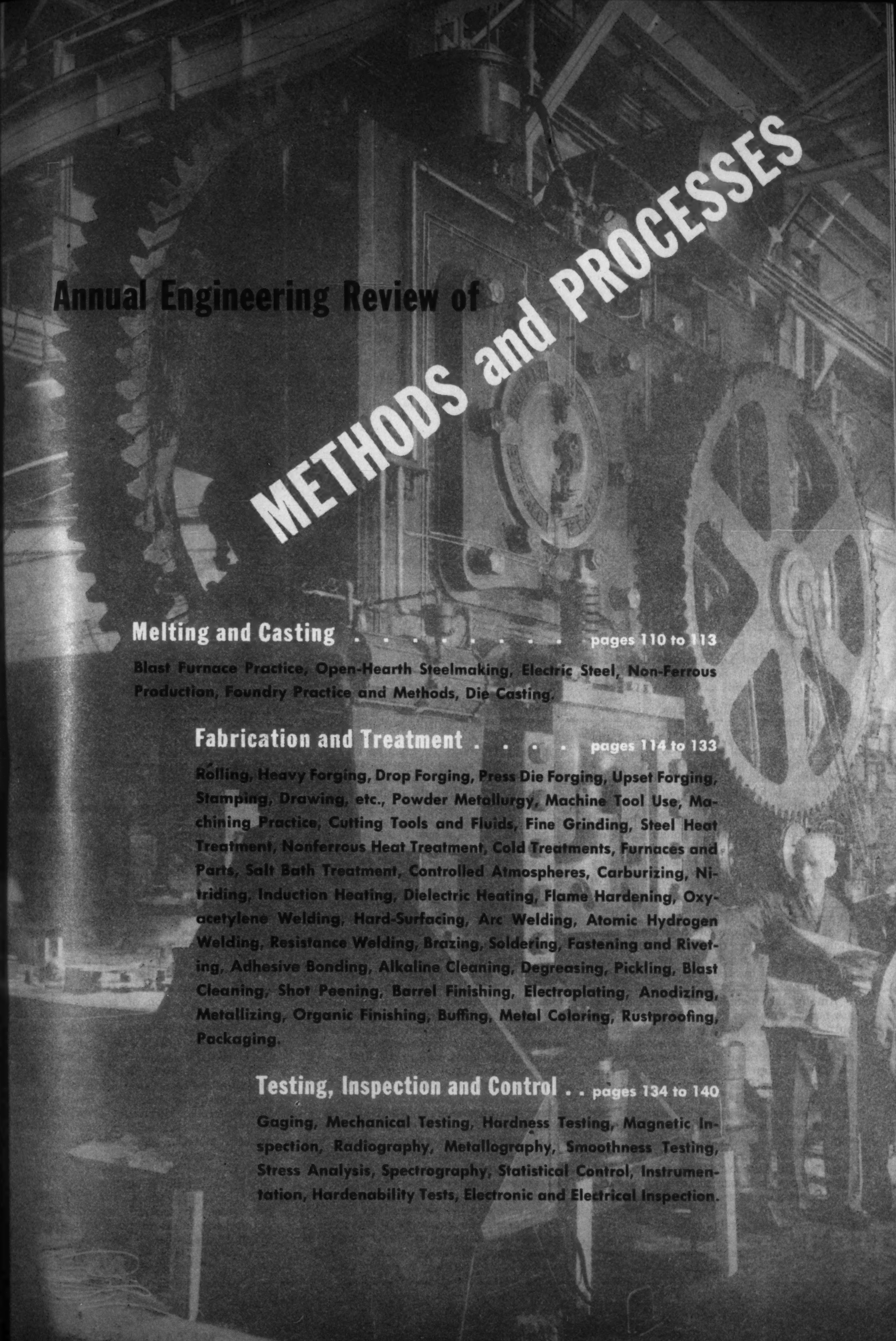
In any selection of materials consideration must be given to their relative ease of processing, which in many cases resolves into a consideration of *machinability*. So far as machinability is concerned, more progress has been made during the past year in applying known fundamentals of structure than in the development of new free-machining metals. Data giving relative machinability values of a wide variety of metals are now published so the freer machining metals can be selected when permissible.

The many leaded copper alloys, nickel cast irons and sulphurized steels now available are of help in this respect. Boron-containing steels are privately reported to have excellent machining characteristics. The use of bismuth as a free-machining addition to various materials, especially stainless steels, is attracting increasing attention. Increased use of the selenium, phosphorus and sulphur-bearing free-machining high-carbon 17% chromium stainless steel was a definite development of the last year.

When chemical analysis is restricted to meet the requirements of a given design, the chemistry of the metal is fixed and the shop has only the microstructure and hardness (from heat treating or cold finishing) to vary in order to improve machinability. Low strength and low ductility are considered favorable to machinability. Materials of low hardness usually give longer tool life than those of high hardness.

However, many times steels of the same hardness have different machining properties because of different microstructure. Thus the soft ductile ferrite and the hard brittle carbide should be so balanced that the latter tends to harden the ferrite and the resultant chip is less ductile and less abrasive. A finely spheroidized structure, a fine pearlitic structure or a modified martensitic structure may be excessively hard, while a lamellar or blocked pearlite, or a coarse spheroidized structure too soft.

The fine spheroidized pearlitic structure in the high carbon oil-quenched alloy steels gives longer tool life than the lamellar pearlitic structure. The machinability of the low carbon steels, in particular, is improved by hardening through cold finishing, so that the cold finished steel gives longer tool life than the steel in the original annealed, hot rolled condition.



Annual Engineering Review of METHODS and PROCESSES

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Blast Furnace Practice, Open-Hearth Steelmaking, Electric Steel, Non-Ferrous Production, Foundry Practice and Methods, Die Casting.

Fabrication and Treatment . . . . pages 114 to 133

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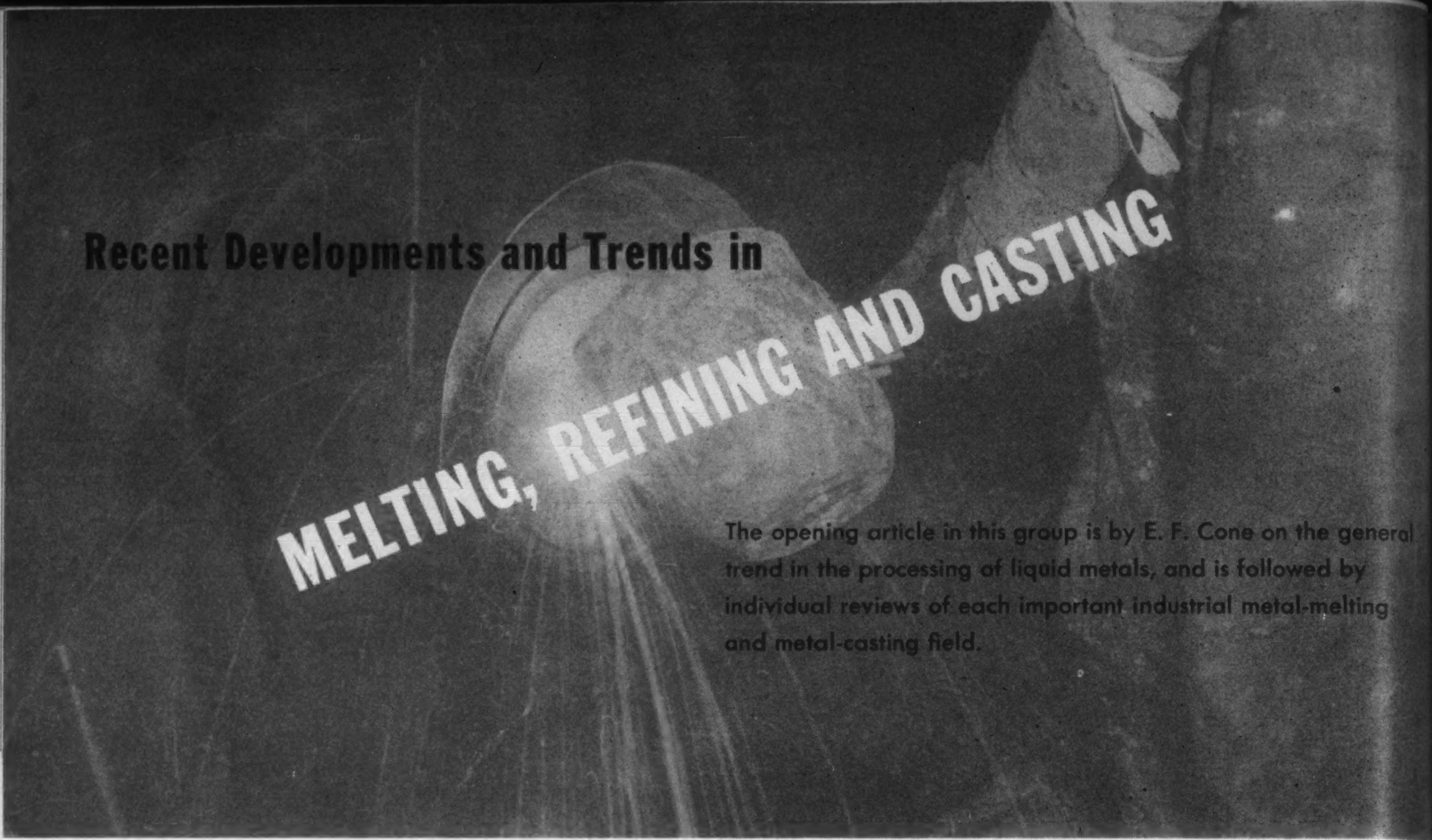


Recent Developments and Trends in MELTING, REFINING AND CASTING

The opening article in this group is by E. F. Cone on the general trend in the processing of liquid metals, and is followed by individual reviews of each important industrial metal-melting and metal-casting field.

Processing of Liquid Metals

by EDWIN F. CONE, Consulting Editor, METALS AND ALLOYS

As the first stage in the production of a finished industrial or consumer product the operations of melting, refining, alloying and casting the metals of which it is to be made are obviously of critical importance. It is gratifying to observe that the processing of liquid metals has kept apace of other wartime technological advances and beyond that has embraced new practices and techniques that are already having a potent effect on the quality of the ultimate product.

Examining these trends broadly, one notes two to be of outstanding significance: (1) The use of metallurgical practices that produce a high-quality material with less alloy content than formerly and (2) the development and applications of mechanical techniques that improve the accuracy of casting and thus permit a casting method of some kind to be used increasingly for the production of precision parts.

Among the metallurgical practices that are having and will have a profound effect on metal quality with a minimum expenditure of alloying metals are the use of small amounts of several alloys in combination to produce the same depth-hardening effect in steel as a larger total amount of one or two alloy additions. This alloying philosophy is the basis of the NE steels, with the current consensus indicating that the old SAE steels will return to a position somewhat but not too far below their former place and that *some* of the NE steels will remain. The price factors dominate all this guesswork, but the important technical trend is that the idea of multiple-alloy additions has considerable metallurgical merit and may reasonably be expected to be a permanent and increasingly important factor in the making of ferrous alloys.

Related to this alloying philosophy is the idea behind the "needled" steels—steels whose hardenability is enhanced by the incorporation of very small amounts of boron. The boron additions introduce their own problems in handling the molten metal but when properly made they do achieve considerable economy in alloy.

Steelmaking as a whole is certain to be affected by these developments. Already, for example, there is much private and some public discussion of the extent to which the use of the electric furnace may be curtailed or expanded because of them.

The second broad trend—increasing interest in and use of techniques for casting metals to relatively precise dimensional tolerances—is characterized by the growing popularity and acceptance of centrifugal castings in brass, bronze and steel; of plaster mold castings in aluminum alloys and copper alloys; of so-called "precision" (lost-wax) castings in brasses, noble metals, alloy steels and special refractory alloys; and of the old standbys die castings and permanent mold castings.

These methods taken as a group now make possible the production of castings in nearly all important industrial metals to tolerances closer than 0.010 in. (and much finer than this with some processes) and place liquid metal fabrication on a par with forging, pressing and other solid-metal processes for the precision manufacture of certain products.

No review of broad trends in working liquid metals can ignore the still-increasing interest in continuous or direct casting of metals to produce long lengths without going through the ingot and cogging stages. Already established practice in the light metals field, continuous casting has reached a surprisingly advanced state in the copper industry and is under intelligent investigation for steel production.

Especially in the nonferrous field there has been a marked trend toward acceptance of secondary-metal charges as sound metallurgy for many types of castings once required to be made entirely of virgin metal. Engineers and metallurgists have determined what "impurities" actually can and cannot be tolerated in compositions designed for specific services, and more specifications now permit the use of secondary metal in castings and die castings than were thought possible five years ago.

In liquid metal processing as a whole the single outstanding trend has been the remarkable increase in technical control and the application of enlightened metallurgical practice in recent years. Steel castings for armor, NE steels held to close composition ranges, uniform-property Bessemer steel, non-aging steels for munitions, magnesium alloys with microporosity of negligible importance, zinc alloy die castings characteristically as sound as other engineering materials, aluminum alloys strong-as-cast, brasses and bronzes with impurities and non-metallics held to controllable minima—all these are typical of the advances made possible by the growing use of directional solidification and modern feeding and risering methods, improved refining practices, raw-material control, advanced pyrometry, spectrographic analysis, radiographic inspection of castings, and many others.

Blast Furnace Practice by RALPH H. SWEETSER, Consulting Engineer

Blast furnace practice in the United States moved forward in a big way during 1944. Blast furnace capacity was brought to the highest peak ever attained, pig iron production was prodigious and research work was conducted in big furnaces on a big scale.

The steel plant expansion program necessitated by World War II was practically completed in 1944, increasing the blast furnace capacity by 12,700,000 tons, and bringing the rated capacity up to 68,446,310 tons per year, with a total of 253 blast furnaces on the active list, including the two remaining charcoal blast furnaces (one in Michigan and one in Tennessee, with a total of 64,480 tons per year), and including the 1200-ton furnace of Lone Star Steel Company, Daingerfield, Texas, not yet lighted. Beginning in June, 1943, the monthly average has been 5,200,000 tons.

The peak production for World War I was about 43,500,000 tons in 1918 with 410 furnaces, the biggest ones with daily output of 630 tons compared with 1500 to 1600 tons today.

Two research problems mentioned in METALS AND ALLOYS a year ago have now been carried out by Republic Steel Corporation. Control of silicon in basic pig iron by steam injection into the blast at intermittent periods has been successfully done at their No. 4 furnace in Cleveland. They then tried a "smothering control" keeping the moisture at 6 grains per cubic foot of blast. At their No. 3 furnace they reached a daily average of 11.40 grains, and an average total moisture of 8.86 grains per cubic foot. The results (published in the October, 1944, issue of *Blast Furnace and Steel Plant*) prove that the optimum moisture in the blast depends on what you want.

The theory that very high gas pressures in the top of blast furnaces would help chemical reactions, reduce "solution loss" and flue dust loss, and increase production, was not generally accepted by blast furnace operating men. With approval of the Office of Production Research and Development and of Defense Plant Corp., Republic Steel is testing this theory in their new blast furnace. There were many expected operating difficulties, but no published reports of progress. D. A. Oliver says "Research is the systematic exploration of the unknown."

Reports on progress in blast furnace practice for the past several years have included some mention of the "sponge iron" process. The latest published report on the Brassert-Cape direct reduction process now being tested at the Warren, Ohio, plant of Republic Steel is that after a month's run the product is up to about 30% Fe.

Open Hearth Steelmaking by L. F. REINARTZ, American Rolling Mill Co., Middletown, O.

During the year 1944 demand for iron and steel has continued at a record rate.

Many plants are using high proportions of "hot metal" in the open hearth charge. This practice has increased production, and has decreased the effect of non-ferrous "tramp" metals in purchased scrap. The price and quality of scrap iron in post-war days will undoubtedly determine whether this high "hot metal" practice will continue. Government control of the practice of alloy steel scrap segregation has improved during the year.

In the operation of open hearth furnaces, continuity of production must be emphasized. Therefore, any changes made during the year have been directed towards that end. Common labor, used in furnace repairs, has been very scarce. Labor-saving devices, such as conveyors, tractors, elevators, slag "busters," etc. have been designed and put in operation to make it possible to use handicapped, below normal men and women.

In a number of plants, because of the scarcity of an adequate number of bricklayers and helpers, steel men turned again to the consideration of suspended open hearth roofs. Experiments are progressing in the use of suspended silica, Mullite, and basic brick.

Several plant managements are trying out all basic ends from the slag pocket on up, including ports and port roofs. Such initial installations are very expensive, and require considerable time to install. Several plants have achieved success by suspending the basic brick in the arches next to the fan tails on each end of the furnace. It remains to be seen whether the savings resulting from increased production per campaign will exceed the increased fuel consumption, and materially increased installation cost.

Slag control is claiming the attention of metallurgists and operators. The viscosimeter, observation of slag cakes, and the petrographic microscope are being used currently in these investigations. It has been found that, under proper supervision, production can be increased by the use of slag control methods because of the more efficient use of smaller charges of flux. This practice will continue to be improved in post-war days. More and more operators are trying to develop practical instruments for measuring molten bath temperatures.

In the open hearth pit, attention is concentrated on improved cleanliness of ladles, molds, etc.; improved equipment for handling pit scrap and other pit materials; and on improved pouring practice.

Metal deoxidation is very important, and is claiming the attention of metallurgists. Many experiments are being made to determine the best methods to follow. There is, as yet, no unanimity of opinion regarding the merits of rimming vs. killed low carbon steels for the improvement of post-war metal surface and internal ingot quality.

Open hearth furnaces, cranes, rolling stock and other equipment have taken tremendous punishment during the last five years of continuous operation. After the war, with the exception of new steel plants built during the war, considerable money will have to be spent in rehabilitating present open hearth furnaces. Most managements are accumulating reserves for such rebuilding operations in early post-war days.

General Foundry Practice by KENNETH ROSE, Engineering Editor, METALS AND ALLOYS

Early in the progress of the war production program, it was apparent that there would be a serious shortage of castings. Many foundries were called upon to make castings to standards higher than those required for peacetime production, and rejects cut sharply into the total.

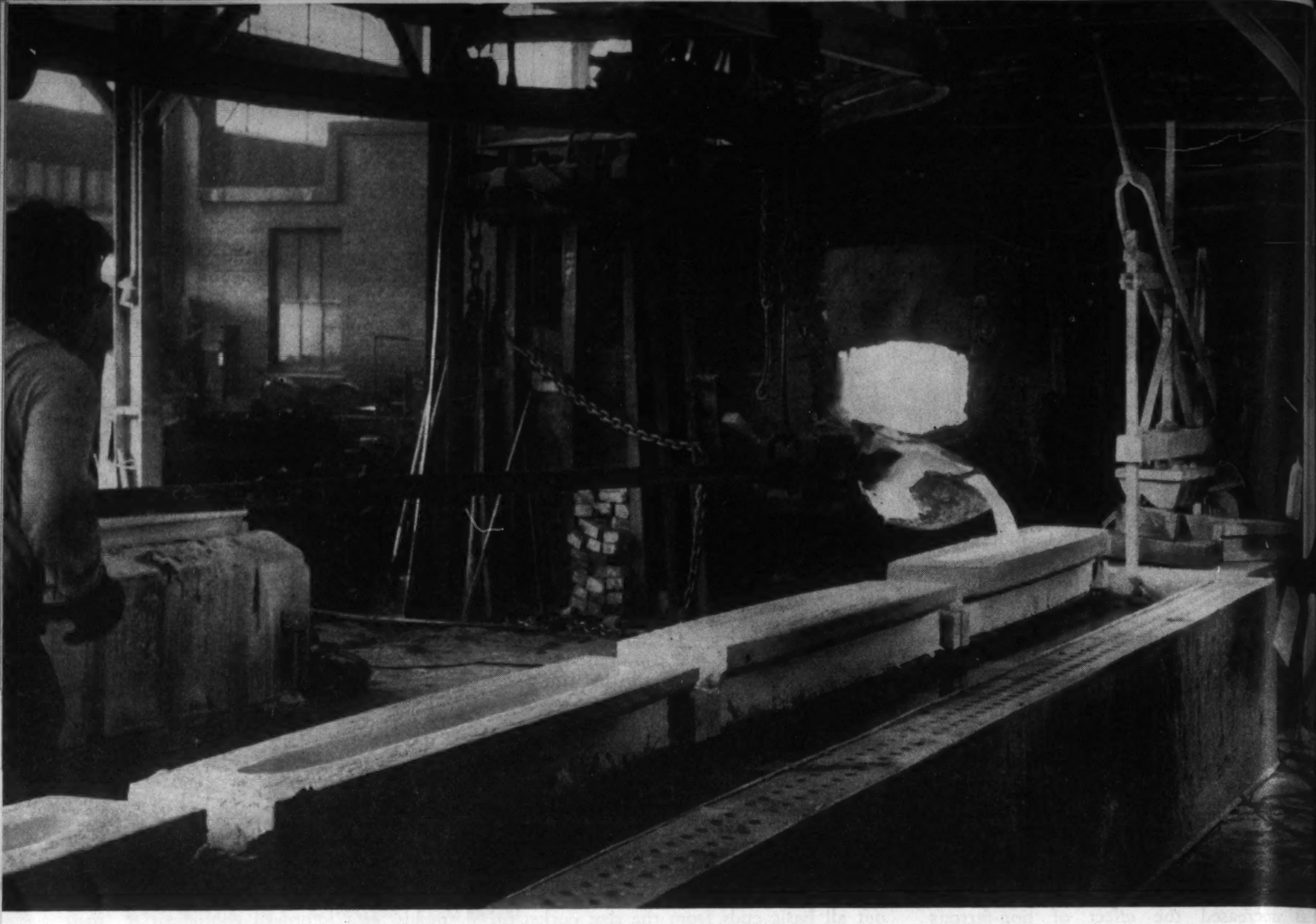
Foundry capacity could not be easily increased, but the reduction of rejects would represent a clear gain in available castings. Several societies, notably the American Foundrymen's Association and the Society of Automotive Engineers, conducted campaigns to improve foundry practice with a view to decreasing rejects. During the past year these campaigns have borne fruit.

Probably the outstanding feature in the progress of foundry practice during 1944 has been the growing recognition of the value of close control by plants that had not formerly practiced it. The statement has been made that the greatest single cause of rejects is incorrect gating and risering. Location of gates and risers is largely in the hands of the foundry foreman, but the design will in many cases limit his choice. There has been a growing tendency for consultation between the design engineer and the foundryman in the course of producing the piece.

The foundryman is giving more attention to such matters as sand control and cooling time. Steel founders are making increased use of blind risering, with the attendant savings in poured metal. Use of very small quantities of boron in malleable cast iron to counteract carbide stabilization is being used by some foundrymen, but is condemned by others. Use of the N.E. steels in foundries is becoming more established as the characteristics of these alloys are better understood.

In the nonferrous field the growing use of magnesium alloys was the most noteworthy feature of the past year. Techniques for the casting of magnesium showed no significant change, but foundries established a greater familiarity with the metal. Our present magnesium production is being channeled almost 100% into aircraft castings, and our foundries are producing work up to the standards set for this purpose.

With the present aluminum production in excess of war requirements, and zinc still "tight," the light metal is being used in the die casting industry in larger proportions than formerly.



Hand pouring copper wire bars at a large secondary metal refining plant

Electric Furnace Steel

by EDWIN F. CONE, Consulting Editor, METALS AND ALLOYS

The American electric steel industry has maintained in the past year the commanding position it had previously attained during the war—it will continue to hold this position as a leading supplier of quality steels for war materiel. And as long as the war lasts, this industry can be depended upon to meet its share of the war's needs.

One of the leading developments has been the expansion of the activities of the Electric Furnace Committee of the American Institute of Mining and Metallurgical Engineers. This new organization held its first meeting in October 1943. Its second annual conference met in October 1944. The attendance of about 600, an increase of 25% over that of the first conclave, and the profitable discussion of technical and operating problems justified the aspirations and hopes of its organizers.

The importance of this movement to the development and success of the electric furnace steel industry can scarcely be exaggerated. It is analogous to the Open-Hearth and Blast Furnace Committees of the A.I.M.E. whose accomplishments over the past several years have been a potent factor in forwarding the development of that highly important branch of the steel industry and in spreading technical and operating knowledge. The new organization promises to occupy a similarly important place in the electric steel industry. Its future is bright from every viewpoint.

A number of technical and operating problems have received active attention recently. Among these may be mentioned: Methods of construction of side walls and bottoms of basic furnaces, some of the factors affecting roof life and linings of furnaces, the loss and recovery of chromium and the control of residual chromium (important from the strategic standpoint), silica and sillimanite refractories for furnace roofs, more rapid estimation of carbon in the bath, gas in steel castings, and so on. Some of these were fully discussed at the convention, and the industry has made decided progress in the solution of many operating and technical problems.

There have been two technical developments of considerable importance. One includes the perfection of a practice that makes it possible for electric steel furnace operators to keep the sulphur content of the steel consistently below 0.010%. This accomplishment has been regarded by many as impractical if not impossible. One steel company has been achieving this as regular routine in making steels for propeller blades. The other development has to do with the manufacture of the 18-8 type of stainless steels whereby large quantities of stainless scrap, even up to 100%, can be used in the charge. It is claimed that, even with such large quantities of scrap, it is possible to keep the carbon content of the bath to the lowest limits necessary.

Another interesting fact is the utilizing of chromium reduced in the furnace from chrome ore as against the use of ferrochromium. This is pointed to as a distinct saving in the consumption of ferrochromium in the high chromium types of stainless steels.

From a production viewpoint, the electric steel industry did not operate in 1944 at the high rate of 1943. In that year electric furnaces turned out steel at the rate of about 5,300,000 tons a year—a record. In 1944 the operating rate is estimated to have been about 4,000,000 tons.

A feature of the past year has been the continued expansion in capacity. If the furnaces which have not yet been put in operation are included in total capacity, it is reliably estimated that the industry's annual capacity is about 6,500,000 tons. But a substantial proportion of this total has not yet been put in operation so that the actual operating capacity is lower.

A problem actively discussed in the industry is the relative position of the electric furnace industry after the war. No definite light on this subject is now available but it is reasonable to expect that an industry of such eminent capabilities in making quality steels will surely find its proper place in the overall picture.

Nonferrous Metal-Producing by HAROLD A. KNIGHT, News Editor, METALS AND ALLOYS

The leading recent developments in the production of nonferrous metals and alloys have been directly related to wartime demands and stringencies often without regard to the normally finely-drawn cost considerations. In addition there have been some interesting trends toward larger production units that *do* have definite economic as well as increased-output appeal.

Some aluminum producing plants were shut down during the year as the supply of that metal caught up with and surpassed the military and essential civilian demand. Projects for producing aluminum from clay were still under development, primarily for use as a last resort in the event of exhaustion or other loss of our higher grade raw material supplies. Expert opinion is that large-scale production of alumina from clay will not be possible prior to 1946.

The most-discussed and seriously considered processes for making alumina from clay have been the lime-soda-sinter process, the Kalunite process and the so-called red-mud reclamation process. Costs are still very high, but there are some who believe they may someday be brought within shooting range of those for conventional production of alumina in this country.

Low frequency induction furnaces are increasing in use for melting aluminum and its alloys. Units much larger than any previously used are now under construction for a special application.

In the magnesium-producing field, some plants were shut down as with aluminum. The probable post-war lineup seems to be taking shape, with the processes based on the electrolytic reduction of magnesium chloride having an economic edge over the carbothermic and the ferro-silicon reduction processes. The retort problem still sits upon the doorstep of the last-named, although retort lives have been considerably extended by using increased wall thicknesses and by expanding or blowing out under high air pressure the collapsed retorts.

In copper alloy manufacture no melting unit has emerged to challenge the dominant position of the low-frequency induction furnace. The trend is toward larger furnaces of this type to give higher melting rates, less power consumption per ton and ability to cast larger cakes or bars. Water-cooled molds with copper linings give greater mold life and better cast surfaces.

New forms available from the nonferrous producers include extruded aluminum bronzes, extruded gilding metal, extruded high-nickel alloys, extruded zinc alloys, and continuously cast products of various types.

As to developments in recovery of metals from scrap, metallurgists have several processes in readiness to apply if market conditions warrant. For emergency purposes the old technology of recovery of metallic copper from copper-bearing material by the cupric ammonium leaching process has been extended—and it may be used in peace.

It is important that an economical way be found to separate aluminum from its alloying elements. Engineers are ready to separate copper and zinc from yellow brass, perhaps red brass alloys also, when it is price-wise to do this, rather than remelt as brass. A sharp rise in tin prices may cause application of known scientifically sound methods to recover tin from scrap.

Then too, there is the possibility of Governmental subsidy to recovery from secondary metals, to conserve our primary metal supply. A secret process for recovering copper may be revealed later and may prove commercial.

Die Casting by L. P. HELD, Mount Vernon Die Casting Corp., Mt. Vernon, N. Y.

The tremendous impact of war work has benefited the die casting industry as a whole and all die casters are in an improved condition for the post-war years because equipment was replaced or modernized to meet new conditions and requirements. Methods of operation were improved due to need for greater production and more rigid specifications.

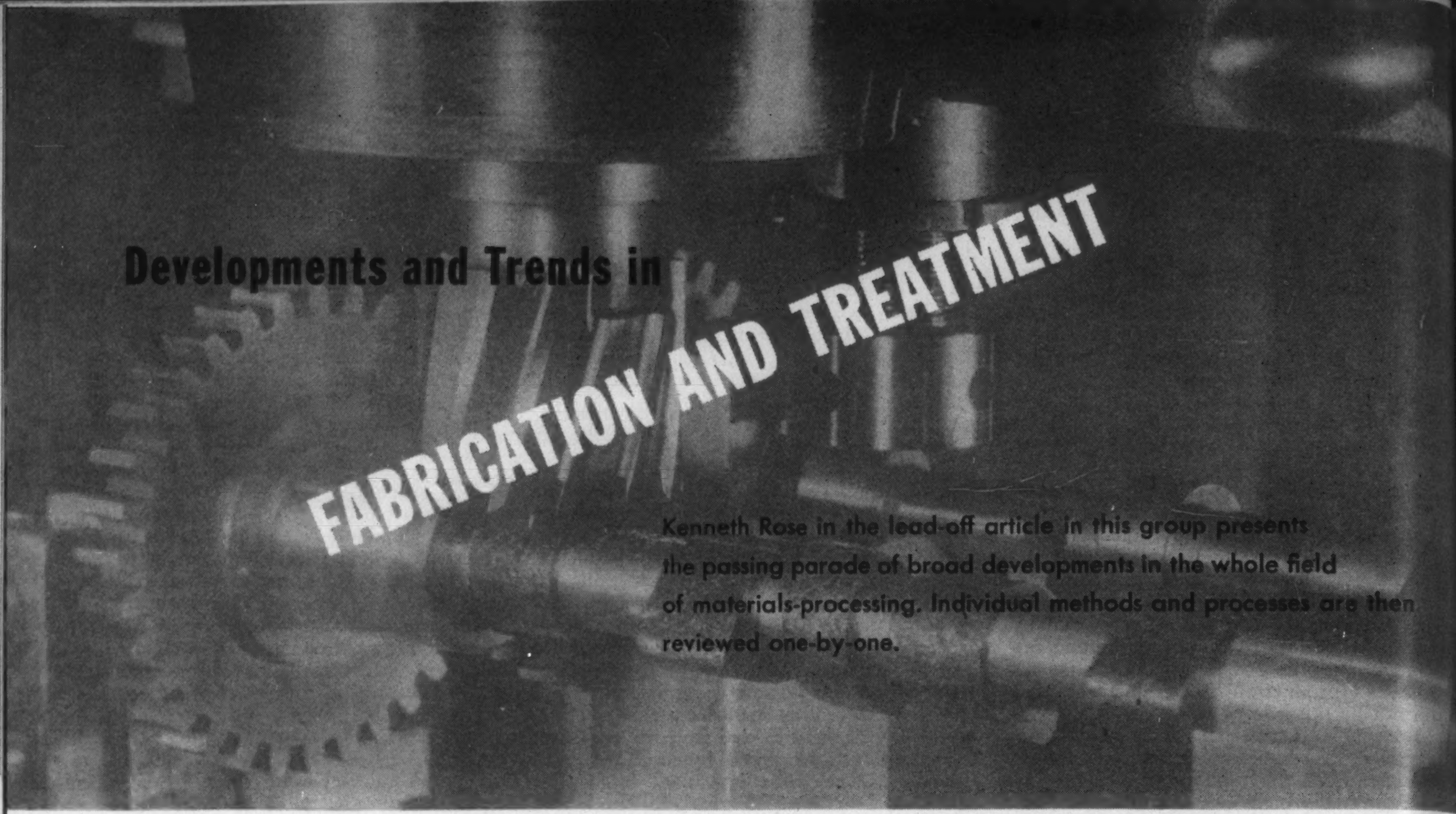
During World War I the die casting industry did not perform or deliver in proportion its performance in the present war. This was solely due to the unstable alloys, inadequate and undeveloped equipment, and absolute lack of controls of the earlier period. These objections remained until 1942 when the industry as a whole showed that it had overcome all its difficulties.

When the demands of the war program became apparent, the die casters realized that a normal peacetime quality would be insufficient, particularly for aircraft castings. Naturally, control of materials and methods of fabrication were scrutinized further for improvement. The first conclusion was that the die casting alloys were excellent provided that during the process no impurities were added above the specification analysis. This meant purchasing raw materials from approved sources, controlling all phases of manufacturing and analysis of the finished product.

The outstanding change or improvement in equipment has been the installation of the cold chamber, high pressure type, die casting machine. Aluminum castings made on this type of machine have proven to be far superior from every standpoint over the conventional "Gooseneck" machine. Many items have been added to the impressive list of "Made by Die Casting" solely to the dense minimum porosity structure of high pressure aluminum die castings. An equally important point is the ability to die cast aluminum and hold to close chemical requirements, a factor which the "Gooseneck" type could never achieve.

The purchasers of die castings, either zinc or aluminum, will be assured of a better product in the post-war period because of the installation of the quality controls and methods necessitated by the armament program. The die casters have been quick to absorb the latest improvements in equipment for all phases of operation. This has resulted in increased output per machine and the user of die castings can be assured that although labor costs have risen considerably, the post-war piece cost will not be changed in any large degree.

Pouring a zinc alloy casting to serve as a die for forming aluminum sheet on drop hammers



Developments and Trends in FABRICATION AND TREATMENT

Kenneth Rose in the lead-off article in this group presents the passing parade of broad developments in the whole field of materials-processing. Individual methods and processes are then reviewed one-by-one.

Processing of Materials into Finished Products

by KENNETH ROSE, Engineering Editor, METALS AND ALLOYS

The most pronounced and the most significant trend in the processing of solid materials to make finished products in recent years has been the increase in engineering control of metal-working operations. This movement has achieved landslide proportions in the war period, with engineers, once important factors only in development and design and certain specialized plant operations, today actually dominating, in addition, most overall production and the individual processing operations in the metal-working industries.

The effects of this engineering control are everywhere evident. Most broadly, we see a general tendency to correlate materials-choice and specification on one hand and process-planning and fabricating procedure on the other, when a company sets out to manufacture a given product. Because of this increasing engineering coordination, the operating department foremen and workmen have less occasion to cuss out the designers and "engineers" for specifying materials that seem difficult or impossible to process efficiently, since either the material has been selected to fit the available processes and equipment, or the latter have been engineered to handle the material.

Another effect of the broader engineering control of plant operations has been increased attention to the *overall* processing of a product—especially determining the sequence of processes and operations and being sure that one method or step fits in with another and that none undoes the work of a predecessor or complicates the performance of a subsequent step. This involves careful consideration of such questions as: shall the part be rough-machined, hardened and finish-machined—or shall it be finish-machined and then hardened by some clean, non-distorting method? Can it be brazed before or must it be brazed after heat treating? If to be welded will that operation draw the hardness, and furthermore if the weld is to be stress-relieved will it be necessary to provide for a final machining or straightening operation to correct any distortion—or should the thing be cast in one piece? With a brazed two-piece electroplated assembly, should the procedure be to plate the components separately, braze them together and buff off the oxide near the joint—or should the parts be first brazed, then cleaned, and the assembly electroplated? It has required engineering coordination and lots of it to keep such situations as these from hopelessly gumming up the wheels of war production.

The rise of the engineer in metal-processing has had other direct and narrower effects. There has, for instance, been a general increase in the use of mechanization and of automatic equipment of all types. Early in the war the engineer was called upon to devise means of stretching out our materials-supply, and this he did by using more heat treating and closer control of heat treating to permit lower alloy content; he manufactured by stamping, brazing, powder metallurgy or casting to relieve pressure on materials, machine tools and forging equipment; he specified plastics for many products and thus forced the introduction of plastics molding or dielectric heating processes into many metal-working plants that had never before done these things. To varying degrees these increases and changes are permanent, for they are based on sound engineering in the first place and will be able to stand up in the closer-costing post-war period.

Other processes that have come into wider use in recent years than they enjoyed before are blackening of all types of metals, and especially steels; broaching as a forming method; press-forging of large parts; extrusion of materials once considered too difficult for this process; engineered rust-proofing and packaging; the production of ultra-fine finishes on metal parts and on tools; hard chromium plating; high speed fastening using various new types of nuts or rivets; adhesive bonding of materials, including metals, to each other; induction heating for several purposes; powder metallurgy; high speed milling of steels; refrigeration of metals; and many others.

Certain broad trends, discussed more fully in the individual-process articles that follow, may be summarized here. In machining there has been a trend toward the use of special machine tools, engineered for each job as a whole, rather than the use of several standard machines each performing one step in the process. The use of carbide tools and of hard alloy tools of various types has also expanded. There has developed improved understanding and more intelligent application of metal-working chemicals—cutting oils, quenching oils, drawing compounds, lubricants generally, fluxes, etc.

Sheet metal forming has undergone some startling changes. Most interesting has been the growing popularity of soft die and punch materials such as zinc alloys, lead, bismuth alloys, Masonite, rubber, cast plastics, etc. for short run production or experimental work. Lofting and layout methods for sheet metal forming have also been radically improved, with photographic methods coming into increased use. Stretching processes and "design-strengthening" are currently attracting wide attention.

The tendency in the forging field has been toward larger forgings and therefore much larger machines than were previously in use. Engineers have spread the gospel of proper use and design of the flow structure of forgings. Methods of heating for forging have been modernized to reduce the time of heating, eliminate or reduce scaling and burning and speed production.

As to heat treating—bigger furnaces, precise and automatic control systems, and greater use of controlled atmospheres, induction heating and electric salt baths have stood out. The idea of "patterned combustion" with radiant ceramic burners to give phenomenally high heat-input rates is taking hold. The use of processes based on the isothermal transformation of steel and the application of "S-curves" in various ways is increasing. Hardenability of steel is now a primary characterizing property and hardenability tests are extensively applied.

Welding's chief advances have been in the direction of much greater use of these processes, greater welding speeds and a considerable improvement in the engineering quality of welds. Materials once considered unweldable are now handled easily.

Perhaps the broadest and most striking engineering progress has been made in the cleaning and finishing fields, which in the war period have gone from generally rule-of-thumb methods to scientifically controlled operations. Better cleaners, carefully engineered cleaning machines, straight-line production set-ups, close control of plating baths as to temperature, composition, pH, cleanliness, electrical conditions, etc., careful attention to racking, thieving and stop-offs in plating, and modern methods of applying and drying organic finishes have been typical of finishing's progress.

The engineer has come a long way in the materials-processing field. Because of that, processing will go a long way, too.

Rolling by F. H. ALLISON, JR., United Engineering & Foundry Co., Pittsburgh

During the past year the mills have been engaged so much in turning out the vast amount of metal needed for war, that there has been little time or inclination to experiment with new methods. The tried and trusted procedure which would insure maximum tonnage and freedom from breakdown has been the watchword.

Only comparatively few shapes, those of war necessity, have been rolled, and this fact together with the large back log of orders has resulted in long mill runs. There has been increased tonnage per run and per individual dressing of the rolls which cannot be expected with peace time orders.

In regard to rolls, the trend in the plate mills and hot strip mills has been to the composite cast, hard alloy iron roll. In shape and bar mills the grain rolls with deep layers of wear resisting metal are being preferred to the shallower depth plain or alloy chill rolls. Blooming mills and slabbing mills are favoring some of the new type steel rolls which give longer wear and freedom from fire-cracking.

Mechanically there has been a wider adoption of the flat-faced wabbler on hot strip mill work rolls displacing keyways which are expensive to make and are troublesome due to breakage. Lubrication has been improved by simplifying the operating parts of grease pumps and feeders. Composition bearings have greatly decreased bearing costs in applications where high temperature makes the lubrication of other types of bearings a problem, the water used as a lubricant also acting as a cooling agent.

The Unitemper mill has received much attention from the tin plate producing companies for temper passing. Instead of conventionally cold working the sheet between pressure rolls, the Unitemper mill continuously stretches the stock beyond its yield point between two sets of gripper rolls. This process increases roll life and eliminates much of the bearing and rolling friction of pressure rolling. Hence it bids fair toward lower operating costs. The sheet produced by the Unitemper mill has a more uniform degree of cold work throughout its section, while the conventional pressure rolled sheet has a greater degree of cold work in the surface layers.

The Krause mill has aroused interest in ferrous and non-ferrous fields since it reduces 26 in. wide strip from ½ in. to 0.030 in. in a single pass. This reduction is accomplished by holding the stock in tension with a gripper while 4 in. diameter rolls are moved over it by frictional contact between the stock and reciprocating cam plates. Pressure is applied only on the work stroke, and the reduction is made largely through the tension in the strip.

Metal from this mill shows a finer and more even grain structure, and edge cracking in copper has been minimized. The relatively slow delivery speed of 30 feet per minute is offset by the reduction being accomplished in one pass. Developments are in progress for making the operation continuous by welding the bars end to end.

There has been some reconversion of the continuous sheet mills, which have been rolling plate, back to their original activity of rolling sheet. This has been attended in some cases with an excess scrap loss while the operators relearn the "know how" of rolling the lighter product.

Electronics, as in other fields, is being applied to the steel mills. Automatic counters, sheet catchers, rod mill shears, runout table kickoffs, and even screwdowns on reversing mills are being controlled by this method. It is also being applied in photo-electric pyrometers, photo-electric inspection of tin plate for pinholes and surface, and for motor speed controls.

The year ahead will probably find demands for post war sections such as railroad tie plates and rails, piling bars, and perhaps automotive sheet. As the war time demand recedes, the old type sheet mills are likely to meet devastating competition from the newer installations. High costs of production due to high wage rates will result in the steel companies seeking every means of improvement in labor saving equipment.

Heavy Forging by J. H. HOPKINS, Hopkins & Kendall, Alliance, Ohio

The forming of metal by forging is the oldest method known yet this process has made the least progress. In the past each forging unit, consisting of a press or hammer, and furnace or furnaces, together with some means of handling the material, was under the direct supervision of the forger. This man in charge of the unit, also computed the weights of metal charged, necessary reductions, number of reheats and method of handling each forging. A heavy forge plant consisting of several units, with a forger in charge of each, might be said to be made up of a series of personalities.

Thus the forging process developed with engineering and planning generally subservient to the practices of the forger.

World War II brought demands for forgings of quality and in quantities unheard of in the past. New plants and augmentation of existing facilities were based on previous production practices. As there were not enough men, familiar with the art of forging, to handle this expansion, it required an entirely new line of thinking to forge on a production basis.

An analysis of the heavy forging program revealed that the weak spot was not in the forging tools themselves (some of the best production records have been made by presses and hammers that originally worked in World War I) but in the methods of handling. Investigations disclosed that no forging press was working even 30% of its productive time. Also, too many reheats were required because the manipulation of the material on the die was slow.

One of the main reasons for the appalling idle time in a forge is inadequate heating. Great strides have been made in the heating of materials. Heating furnaces have become what might be termed "heating machines." Application of these advancements to heating in the forge shop—a virgin field—has resulted in more productive hours, more material properly heated, and less fuel consumption per ton of metal heated.

A rearrangement of the preconceived relationship between the heating and forging units has made for simplification of material handling and greater production.

It is interesting to note that all through the 50-yr. development period of the forging manipulator, its acceptance by the trade was not enthusiastic, but when the war came, demanding new plants, and increased operation with unskilled labor, the forging manipulator finally came into its own. Mechanical manipulation had to be recognized, for faster handling of the material in the die.

The outstanding progress in the heavy forge can be summed up as follows: (1) new overall thinking of the forging process, (2) advanced methods of heating and, (3) material handling. The above factors have led to a greater utilization of the inbuilt speed of the press. Present day forging production proves the soundness of this revised thinking and suggests the type of improved engineering that lies ahead.

Drop Forging

by EUGENE C. CLARKE, Chambersburg Engineering Co., Chambersburg, Pa.

The forge shops and the aircraft drop shops have pounded out a rugged answer to the tremendous demands of war, both in quality and quantity. The job they are doing is a standing tribute to the managers and craftsmen of these shops. They have improved their techniques and increased their output out of all proportion to the capacity made available to them. They have done it at a time when new tools, repair parts and materials were under the most rigid priority control. In spite of these, their performance has been magnificent.

In doing this job they were not alone. Metallurgical advances have increased the number of metals and alloys capable of effective drop forging, and have enhanced their physical properties. Greater precision in die making techniques has made possible better economic utilization of the impacting tools and closer tolerance forging.

Improvement of heating and heat treatment practices and equipment has enabled better control and greater refinement of the finished product. Manufacturers of impact die tools, the drop hammers, the forging hammers, the trimming presses, and the drop stamps, have improved their products apace. Greater impact per increment of impacting mass, faster get away of ram, more delicacy of impact control, greater economy in maintenance and power, greater rigidity of alignment—all of these and others were brought to the job by those who design and build the tools of industry.

One final source of assistance cannot be ignored. That is the filling of the gap left by insufficient forging capacity to meet radically mounting wartime needs. The steps taken by leaders in the fields of pressing, stamping, and casting to fill this gap in capacity have undoubtedly prevented a serious shortage of drop forged items from becoming a real catastrophe.

The implications of jet propulsion, gigantic turbine generation, super-charged, high octane drive, universal air freight and passenger transport are even more far-reaching than the wartime factors that have been operative on the industry. The quantity of light-weight, high-strength components, the multiplicity of materials and shapes, and the physical uniformity and close tolerances that will be required stand as a stimulating challenge to the industrial team that has responded to all such challenges in the past.

The team has already begun to formulate the answers that will assure its optimum post-war participation in an expanded world economy. It awaits only the end of its wartime job, and attendant restrictions, to develop highly significant new techniques, processes, and equipment for the peace.

Press Die Forging

by F. G. SCHRANZ, Baldwin-Southwark Div., Philadelphia

The old method of producing forgings on steamhammers, drop hammers, air hammers, or mechanical presses was many years ago supplemented by the steam hydraulic forging press. This development in turn has led to the use of the straight hydraulic accumulator-operated forging press and very recently to the oil hydraulic self-contained forging press.

These types of presses receive their power from rotary piston type oil pumps. The most frequent use of oil pump operated forging presses is for forging work where common hammer dies are used for reducing billets or ingots into shafts or bars of various shapes.

However, when a finished article is to be forged into a form die, good judgment is to be used when employing the oil operated press. Due to the dwell at the bottom of the stroke on a hydraulic press (that is, the few seconds required to open the forging die and eject the finished forging), the dies will heat up excessively, shortening the life of expensive forging dies.

There are quite a number of oil pump operated hydraulic forging presses now in use. However, such types of presses when equipped with self-contained oil-pumping units are limited in capacities.

A 24-in. ingot can be forged on a 10-ton hammer which is equal in capacity to a 1200-ton press. A 1200-ton press operating with 3000 p.s.i. oil pressure requires a 30-in. diameter piston having a displacement of 3 gals. per one-inch stroke.

If on die forging work this one inch stroke has to be made in three seconds, the pump will have to supply nine gallons in three seconds or at the rate of 180 gals. per min. and thus requiring an approx. 250 hp. motor. The largest oil pump manufactured today is of 400 gal. capacity operated by a 500 hp. motor when used for 2500 lbs. working pressure.

3000-ton die forging presses hydraulic accumulator operated are successfully used for aluminum forging work where the forging temperature is rather low. 1000-ton oil-pump operated straight forging presses with a 200 hp. motor are doing excellent work in Government forge shops.

A year-end development of considerable interest to the forging field was the announcement a well-known New England plant is to undertake the production of very large magnesium forgings, using a press (now under construction) with a rating of over 15,000 tons pressure. This will add magnesium alloys to the existing group—aluminum alloys and steel, primarily—in which we have learned to make large press forgings in recent years.

Powder Metallurgy

by FRED P. PETERS, Editor-in-Chief, METALS AND ALLOYS

The broadest and most significant recent trends in the powder metallurgy field have been in the applications of the process and in the design of powder metallurgy parts, discussed by Mr. Seelig in his article in the "Parts and Fabrication Methods" section. There have been some processing advances, however, that are worth noting.

The trend toward larger presses continues, with 5000-ton hydraulic and 1500-ton mechanical presses now available. The timing of presses of the high speed hydraulic type has proven highly satisfactory.

In an able review of powder metallurgy presses and processes published during the year, E. V. Crane and A. G. Bureau of E. W. Bliss Co. report favorable consideration (for hot pressing) of transfer feed presses to combine closely progressive heating and dense pressing of powder preforms.

Double acting presses are now available in many sizes in both mechanical and self-contained hydraulic types. While the particular application should always be considered and may readily alter the selection, practice seems to bear out the choice of mechanical equipment for quantity production of porous compacts. For dense parts and especially for closed dies where the powder charge cannot be controlled precisely or where other unknowns are present hydraulic equipment offers close control of working pressures, with the fast self-contained hydraulics providing flexibility and fast adjustment where needed.

Sizing or coining after sintering is increasing in use for producing parts to close dimensions. At the same time sintering furnace practice and handling have been improved, with closer temperature control and more mechanization evident.

Several new or modified types of powders have recently been developed, among them a 99.9% hydrogen-reduced cobalt powder, a 99.75% electrolytic manganese powder, a 96% milled silicon powder, spherical brass and copper powders, a 5-micron graphite powder and several types of alloy powders (including beryllium copper, nickel-copper, nickel-chromium-iron, etc.) not previously available. Powders finer than 1 micron are being used for certain applications, also.

During the year the Navy Department developed a technique for making "strong" iron parts, using a copper-coated iron or steel powder which was pressed to shape and the briquette heated above the melting point of the copper so that the latter "brazed" the mass of iron particles together (analogous to the matrix-bonding of tungsten carbides by cobalt in carbide-sintering). So far as we know this project is still in the experimental stage.

Upset and Machine Forging

by R. H. JONES, National Machinery Co., Tiffin, Ohio

One of the most far-reaching developments in the forging field is the development and application of the modern high speed forging machine (for example, National Machinery Co.'s Maxipres) for making large steel and light metal forgings of the type once producible only by hammer forging or by casting and machining.

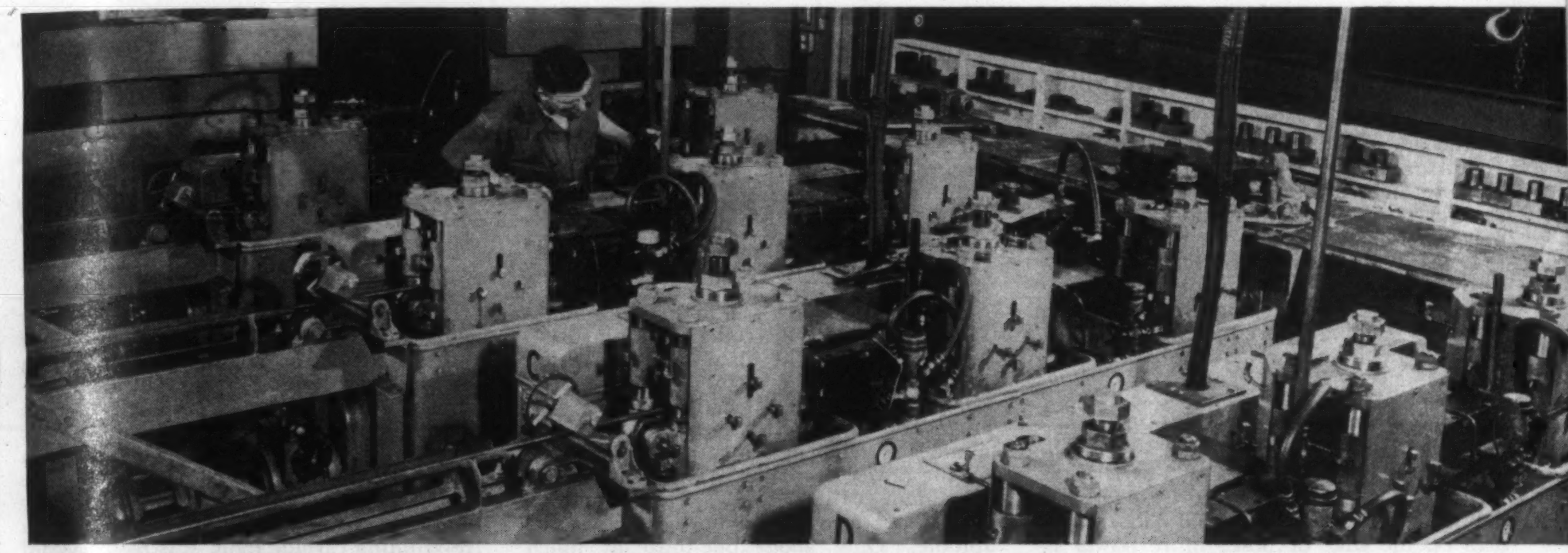
There is every indication that during the early post-war years there will be worldwide activity in this forging field. Developments brought about as a result of extensive application of these machines on war work have opened up almost limitless possibilities for their use in the mass production of low weight, minimum finish, precision forged parts in endless variety for civilian needs.

Machines of this type are now available in eight standard sizes ranging from one weighing 32,000 lbs. and having the ability to produce in one blow in each die impression, the size of work regularly handled on a 1,000 lb. board hammer, to a huge machine weighing 800,000 lbs. and comparable in its ability to an 8,000 lb. steam hammer.

Radical improvements in design have resulted in greatly increased rigidity and much more accurate alignment. Die detail is filled with a minimum of flash and die match is perfect. Positive, high speed ejection of the work from the die aids in prolonging die life and increasing output.

While the importance of these improvements should not be minimized, they are, however, far overshadowed by the greatly increased speed of the recently manufactured machines. This extremely high speed, plus the increased rigidity, causes the die detail to fill with a minimum of flash. Since the hot stock is in contact with the die a shorter period of time, the die life is also improved.

Furthermore, a material increase in output—two or three times that ordinarily secured on hammers—is another marked advantage of this increased speed. Add to these important considerations ease and convenience of feeding and freedom from production delays for excessive repairs and adjustments, and it is apparent that the war record of these large press-type forging machines is only preliminary to that which it will establish on peace-time work.



Operating installation of four induction hardening machines for the continuous hardening and tempering of steel bars

Stamping, Drawing, etc.

by R. W. GLASNER, Clearing Machine Corp., Chicago, Ill.

Important developments in the design and construction of both mechanical and hydraulic presses expedient to wartime production, should be carefully evaluated by metal stampers, as these advances will be significant in solving postwar production problems.

Presses of the latest design make possible greater accuracy and have greater adaptability. The modern press will reduce "after press" work, their production being much closer to the requirements of dimensions and finish than the products of older type presses.

The new types of hydraulic presses include remarkable improvements such as more accurate speed control, higher operating speeds, extreme accuracy in pressure control, and ease of moving metal in and stampings out of presses. In fact, the "gremlins" of the prewar press can be forgotten, provided the proper press selection is made.

To make maximum use of these new developments press men and die set-up men should understand fully the capacity limitations of each press. Stampers should handle presses the same as a machine shop man handles milling machines. Presses of old designs should be replaced as rapidly as possible by presses which include all new developments making for better and cheaper production.

There will not be any considerable surplus of new type general purpose presses after "D" day. But there will be a surplus of presses with narrow beds and long stroke designed and used in the production of cartridge cases. A few of these "single purpose" presses will be used after the war in the mass production of long tubular shapes such as various types of oxygen or gas bottles.

The airplane industry has been the largest purchaser of large modern general purpose presses during the war. This industry has been an important factor in the tremendous expansion in the use of short run, relatively cheap dies and tools. Dies from cast zinc alloy have been found to be satisfactory for runs of 500 to 1000 pieces. Stampers can and should profit from the experience of this industry in the development of civilian products. Trial runs for new models can be made, *i.e.,* a small number of new models can be produced at a moderate cost and the market acceptance tested before final mass production dies and tools are made. This development alone will materially assist in opening up new markets for stampings by permitting a more economical study of their possibilities.

A completely new and interesting war development is the new method of aircraft propeller construction. This propeller is made on a horizontal type hydraulic press by forming a metal tube. The tube is inserted in the press, and in this instance, the dies move. The split die of the ultimate propeller exterior form closes in on the tube at a predetermined point. When the dies are nearly but not completely closed, an inert gas, under 400 lbs. pressure is introduced inside the tube. This pressure, and the slightly open dies slightly over-expand the tube. As the dies finish closing they complete the forming of the propeller with a smooth exterior made to the accuracy required.

Machine Tools and Their Use by TELL BERNA, National Machine Tool Builders' Assn., Cleveland

The production of the huge amounts of war materiel required during the past few years has provided a laboratory in which improved methods of machining have been developed and during which new and different materials have appeared. From these experiences trends are emerging which will benefit industry in the coming competitive era.

Modern designs of machine tools have met and often anticipated requirements. However, the availability of new and different materials, such as the light alloys, may make higher speeds and feeds desirable—features which will in some cases necessitate fundamental design changes, and extensive research in the design and lubrication of bearings.

In order to take maximum advantage of improvements in cutting tool materials and the forms of cutters, more rigidity may have to be provided and power increased on machine tools upon which they are used.

Interesting and important as are the recent advances in high speed milling, they probably will not alter the basic characteristics of milling machines.

In many plants, it has been found advantageous to combine as many operations in one machine as practical, and undoubtedly this tendency will continue.

Electronic controls have become sufficiently dependable so that if cost can be reduced, application to machine tools may greatly increase. This may result in the elimination of some gearing and simplification of driving means. Predetermination of sequence of automatic operations by electronic control may be more widely used.

As a result of war experience and cost factors, much attention will be given to reducing set-up time, to getting the work into and out of the machine, and to chip removal. The one great opportunity that still remains to reduce costs in machining is the reduction of "down time," much of which is unnecessary.

Many of the extremely ingenious feats of tooling used during the war years will undoubtedly carry over into peace-time applications, but indications are that they will not greatly alter basic machine tool design. Three-shift operation under pressure has emphasized the desirability of easy servicing and maintenance and appropriate modifications, where necessary, will be made. Machine tool design, while retaining its time-tested basically sound features, will be sufficiently flexible to meet new requirements as or even before they arise.

Machining Speeds, Feeds, Power, etc. by O. W. BOSTON, University of Michigan, Ann Arbor, Mich.

The use of high cutting speeds to secure good surface quality is increasing. Cast alloy or sintered carbide tools must be used for this purpose. Further, the maintenance of normal or heavy feeds per tooth in milling has been found desirable with high cutting speeds even though it is necessary to reduce the number of teeth in a milling cutter to 6, 4, 2 or even 1, in order that the present low powered equipment can be used.

In face milling steel, cutting speeds from 700 to 900 f.p.m. are used with a feed per tooth of 0.006 to 0.012 inches. Negative axial and radial rake angles of 5 to 10° are used so as to start each cut by engaging the work on the carbide tool face rather than on the edge or nose. More power is required but until the sintered carbide tools are capable of carrying positive rakes the metal must be kept in compression.

The high cutting speeds give superlative surface finish on the work and the heat developed in the chip by its removal is carried off in the chip before it can pass into the tool or work. Naturally the future will see higher powered and more rigid machine tools so that cutters with more teeth may be used and the production capacity of each machine increased many times.

When machining aluminum with high-speed steel or carbide cutters, cutting speeds of 5,000 to 15,000 f.p.m. are now being used. The feed per tooth is maintained as 0.004 to 0.008 in. Usually, positive rake angles of 10 to 15° are used and the number of teeth in the cutter is dependent on the power available. About 3 cu. in. of aluminum (14ST, 24ST, 17ST) are removed per minute per horsepower at the spindle. Only about one-third as much steel is removed under similar conditions.

Of late, emphasis is placed on machine grinding cutters to produce geometrical accuracy and a fine surface quality of 1 to 15 microinches. Diamond abrasive wheels are being used increasingly to finish the tools. These wheels are made in several grades of resinoid, vitrified and metal bonds, each with diamond grit sizes from 60 to 500. The vitrified bonded diamond wheel is now proving superior to the others.

For rough grinding grits of 60, 80, or 100 are recommended, or a silicon carbide abrasive wheel of 60 grit in a medium soft grade. For finishing, diamond wheels of 80 to 220 grit or finer are used, or silicon carbide wheels of 100 or 120 grit of medium soft grade. Tools for machining aluminum and magnesium should have the best finish and a keen cutting edge. A coolant or oil should be used with these diamond wheels to keep them cutting freely and prevent the tools from overheating. In re-grinding carbide tools, it is recommended strongly that all cracks and flaws be removed completely.

During these critical times it is more important than ever to develop, standardize and put into practice every possible improvement.

Fine Grinding and Polishing by E. C. SUCHER, Carborundum Co., Niagara Falls, N.Y.

In recent months more and more engineers have concluded that the high luster, "mirror" finish is not always indicative of good surface quality as a dull, matte surface may be superlatively good, while a "mirror" surface may actually be quite rough. The best means of definite measurement for evaluating surface roughness is the r.m.s. (root mean square) method. The results of this method have definite meaning and are readily understandable to everyone concerned with the finish.

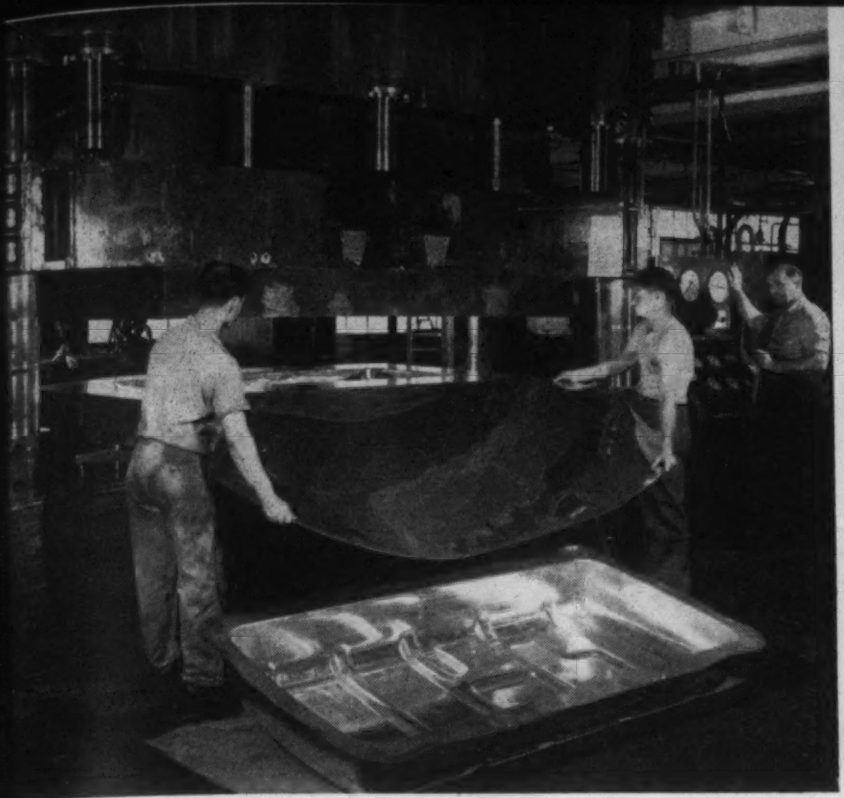
Experience has shown that the grinding machine must be relatively modern and in the best possible condition if a finish approximating or bettering 2 micro-inches is to be obtained without lapping or honing. It is impossible to produce a truly fine finish if any one of the following conditions prevails:

1. Inadequate power
2. Wheel spindle in poor condition
3. Vibration
4. Belts of uneven thickness or pliability
5. Loose or out-of-balance idler pulleys
6. Backlash in drive gears
7. Worn traverse drive posts
8. Misalignment of headstock and tailstock or of wheel-head and work

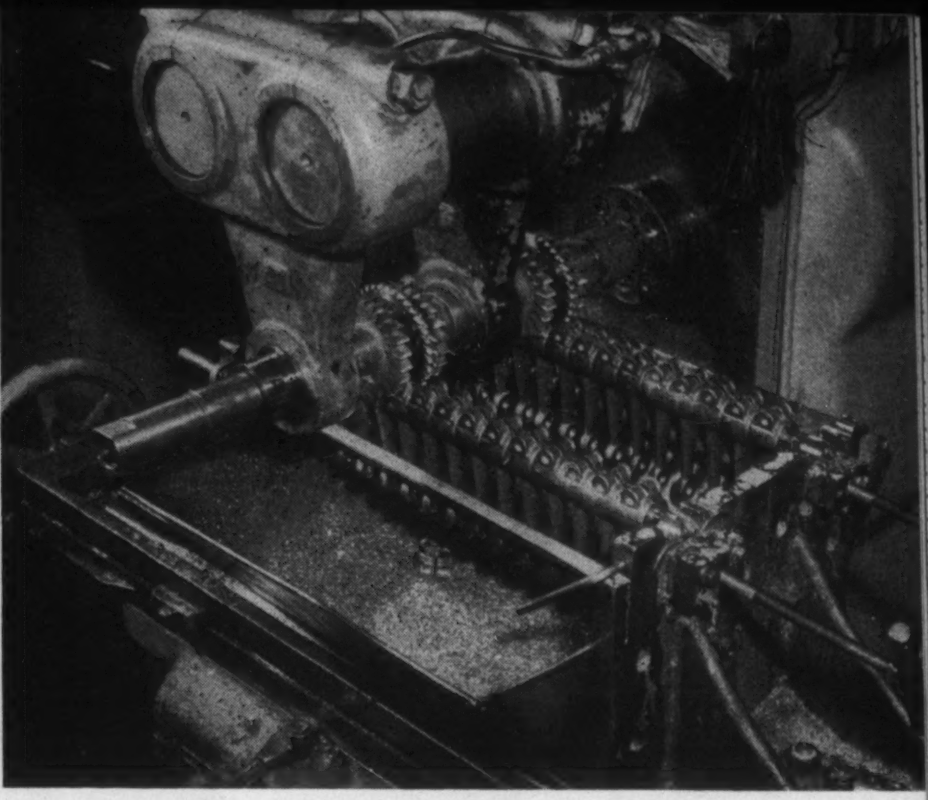
Even though chosen carefully and intelligently, the wheel may act too hard or too soft. If the wheel loads, glazes, or does not cut freely, increase the wheel speed slightly until the wheel action is right. The increased wheel speed will produce a softer action. Obviously, if the wheel acts too soft the reverse is called for.

Another procedure rarely used although quite effective, is to change the direction of work rotation. That is, the wheel and the work move in the same direction. Of course, the wheel moves much faster so that there is cutting action.

In many cases the finish produced has been improved by "doctoring" up the wheel face. The problem of producing a finish fine enough to make unnecessary a lapping operation was solved by the advice of one abrasive engineer, who suggested painting the face of an ordinary 180-grit wheel with a lapping compound composed of 800-grit aluminum oxide grain in a soluble oil vehicle. The resulting surface was nearly zero microinches in roughness.



Deep-drawing aluminum on a hydraulic press



An ingenious setup for milling 40 pieces at one loading

Cutting Tools and Fluids for Machining

by O. W. BOSTON, University of Michigan, Ann Arbor, Mich.

Over a period of years we have had nitriding, chromium plating (or flash plating), both of which have proven effective. *Nitriding* tungsten and molybdenum types of high speed steel tools (previously hardened and tempered) is carried out in a liquid bath of a mixture of sodium and potassium cyanides at a temperature of 1025 F to 1050 F for 15 to 40 min. Finishing tools require the shorter times. All types of tools have shown greatly increased tool life because of this treatment.

The *flash chromium plating* of tools has also proven effective on many jobs. Both nitrided and plated tools treated on the face should be re-ground on the flank only or else be re-treated after each grinding. Fine finish grinding is recommended prior to both treatments.

Liquid honing or vapor blast is a new process developed to improve the performance of high speed steel tools and some very favorable performance data have been obtained for tools so treated. The *subzero treatment* of steel tools after tempering, at a temperature of -110 to -120 degrees F for 2 hrs. to complete the transformation of austenite to the harder martensite, followed by a second tempering, improves the performance of tools not properly hardened originally. This treatment has also been of value in bringing 0.0002 to 0.0004 inch undersize component parts up to accepted size by a 24-hr. treatment at -70 F.

Marked improvements have been made in some of the cast tungsten-cobalt-chromium alloys. The new Stellite, No. 98M2, and similar materials may now be used for heavy feeds and cuts on steel as well as on brass, bronze, cast iron, hard rubber, etc. These tools yield results between those of high speed steel and sintered carbide.

A new high-cobalt high-speed steel is now heat treated to give a hardness and performance well above those of the usual high-speed steels. Limited reports of an outstanding nature have been made.

There has been a steady improvement in sintered carbides for cutting tools. Resistance to both shock and abrasion has been improved. The technique of grinding these tools has been perfected.

Cutting fluids are perhaps the most misused of all factors leading to successful production. Improvements in both oils and water emulsions have been made during the year. Additives to both types in the form of sulphur, chlorine, graphite and fats have been developed to increase materially the production or tool life, surface finish and chip form.

The more effective application of a cutting fluid in large quantity and at high velocity on the chip and tool has become more general. A great deal of progress has been made in the control of the temperature of the cutting fluid. It has been found that the cutting speed can be increased about 18% by cooling an oil from 150 to 70 F and about 10% by similarly cooling an emulsion. The most effective temperature at which to apply cutting fluids is from 70 to 85 F. At lower temperatures oils become too viscous and fats in emulsions are liable to congeal.

Metallurgy of Steel Treatment

by W. C. SCHULTE, Curtiss-Wright Corp., Propeller Division, Caldwell, N. J.

Only within the last few years has the heat treatment of steel changed from an art to a science. In the past, the selection of a steel for a given part was largely a matter of "trial and error." The design engineer may have had a rough idea of the physical properties needed to withstand the stresses imposed on the part, but the metallurgist just "guessed" at the kind of steel that should be used. As a final check of the validity of the various assumptions and guesses, the part was service tested. Then, and only then, could the success of the part and the choice of the steel be determined.

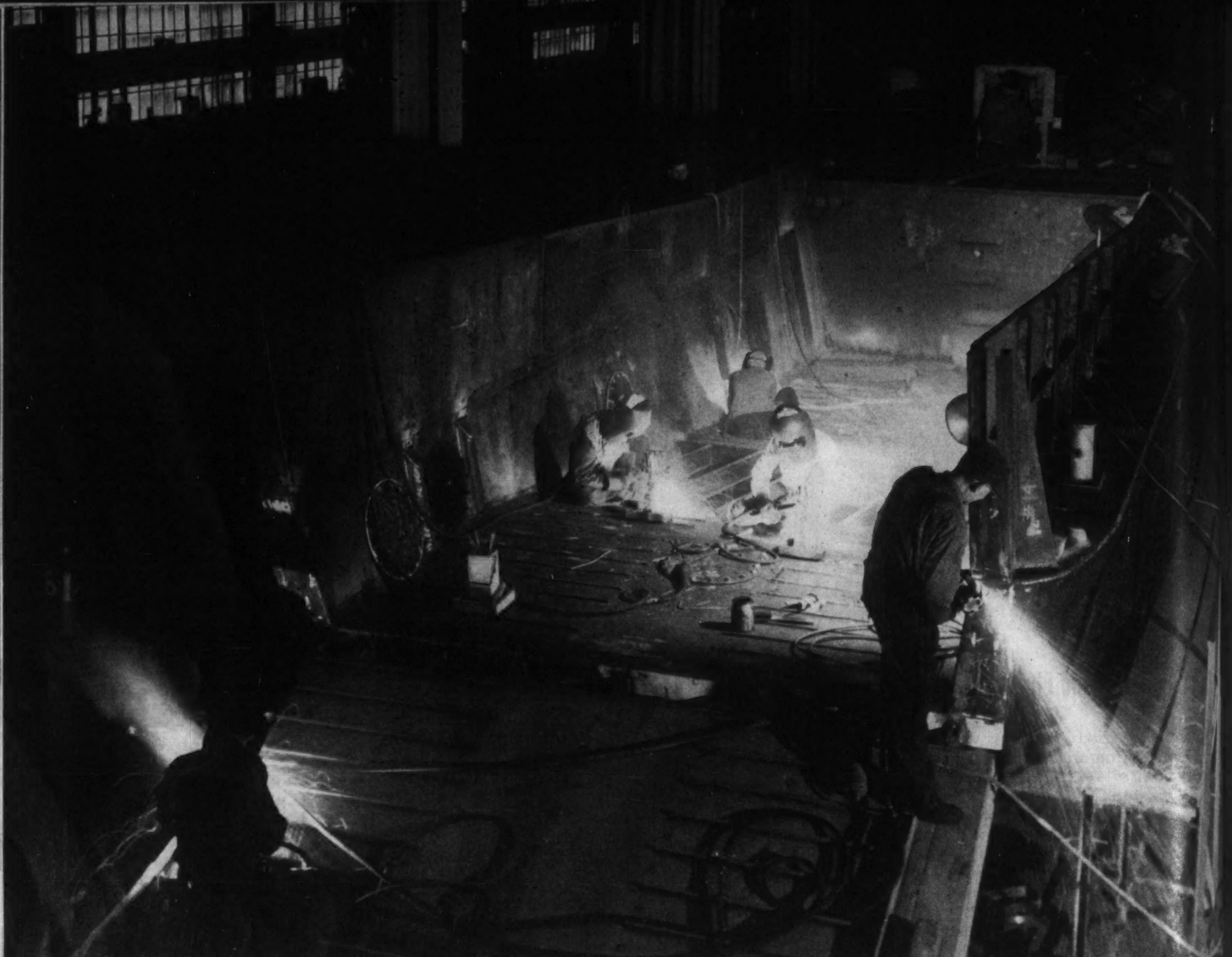
A.L. Boegehold and others have recently shown how it is possible for the materials engineer or metallurgist to select the proper steel for a particular part by comparing the hardening power of the several steels available with the strength requirements of the particular part. The first thing to be done when selecting a steel for a particular part is to find what cooling rates occur at various points when that particular part is quenched.

A simpler method of doing this is based on the fact that the as-quenched hardness of any steel is determined by the speed with which cooling occurs during quenching, and involves hardening a piece of the steel so as to obtain a wide range of hardnesses in the test piece from the surface to the center after hardening, and also end-quenching a Jominy hardenability bar of the same heat of steel from the same hardening temperature; the equivalent cooling rate value for any "as-quenched" hardness value may be determined from the Jominy end-quenched hardenability bar of the same steel.

By this method it is possible to determine the cooling rate at any point in the part. With this information, and a study of the Jominy hardenability curves of the various types of steel available, it is possible to select a steel which will produce the required hardness specified by the design engineer.

Another outstanding achievement has been the practical application of the theoretical concept of "isothermal transformations." The processes of "Austempering" and "Martempering" have found very wide application in the heat treatment of U. S. Ordnance parts and other war material. One plant has shown a record of over 3,000,000 shell fuses "Martempered" without a single loss due to quench cracks or warpage.

Guided by the data from "S" curves, the engineer or metallurgist has been able to take the guess work out of "time quenching" and expose much of the mystery of quenching mediums. Calculated and experimental hardenability data have pointed the way to the scientific selection of steels for engineering applications.



The expanded use of welding in shipbuilding is typified in this view of women welding the deck plates of a landing barge

Heat Treatment of Nonferrous Alloys

by C. H. SAMANS, American Optical Co., Southbridge, Mass.

The release of hitherto restricted information concerning the processing of the newer alloys has been the main source of nonferrous heat treating developments in 1944.

The high strength aluminum alloy, 75S, requires special heat treatments to produce optimum properties. Maximum workability and freedom from age hardening are developed by a two-stage annealing heat treatment consisting of a recovery or re-crystallization stage followed by air cooling and a precipitation stage at a lower temperature. A solution treatment followed by a quench and an elevated temperature precipitation treatment is required in order to produce the fully heat treated condition although, unlike the older 24S, 75S continues to harden for an indefinite period at room temperature after quenching from the solution treatment.

If maximum strengths are to result, artificial aging must be started within a definite time after quenching. If this alloy is to be spot welded, forced aging may either precede or follow the welding. Welds treated by either procedure will give approximately the same shear strength and will meet existing specifications, although material aged before welding will have a somewhat higher tensile strength.

The corrosion resistance of Alclad 75S-T is said to be less affected by diffusion than the older 24S-T and hence a greater number of reheat treatments can be given it.

The high strength aluminum alloy, R-301, is much less susceptible than competitive alloys to over-heating during solution treatments, even by as much as 20 to 30 F. Depending upon whether forming has to be done after aging different elevated temperature aging treatments are recommended for this alloy.

In bronze castings certain types of porosity are said to have been materially reduced by suitable stress relieving treatments. These heat treatments have no effect on the mechanical properties and are applicable only to otherwise sound castings which show porosity under hydraulic test.

New auxiliary equipment has been developed which materially improves the electrical controllers of one of the larger manufacturers. Once this control is set for a particular furnace, the temperature is automatically held firmly and steadily in line in spite of changes in furnace load, soaking temperature, outside temperature, or other disturbing factors, large or small. Existing controllers of this type can be converted readily to the new and more accurate method.

Salt baths continue to find favor as heat treating media, although, in the solution heat treatment of aluminum alloys, a return to the use of circulating air furnaces appears to be developing. This seems to be largely a question of convenience, the use of bottom doors in circulating air type furnaces making direct water quenching into subfloor tanks comparatively simple. Experience has shown also that the economic advantage of salt baths for nonferrous treatment is not as marked as had been anticipated.

For smaller parts an electrode furnace in which the salt is heated in a ceramic pot has been developed. Even when used at high temperatures the electrodes have a life of from two to three months and the ceramic pots last eight to twelve months.

It is probable that most of the major developments in this field in the immediate future will continue to result from the release of processes which have hitherto been restricted for security reasons. This is a natural trend in a period of decreasing war production and increasing reconversion.

Cold Treatment of Metals

by HAROLD A. KNIGHT, News Editor, METALS AND ALLOYS

Accelerated development of war production techniques have brought to the fore treatment of metals to minus 120 F with mechanical refrigeration or even minus 300 F or more with liquid nitrogen or other agents. In a real sense such temperatures are still heat treatment since one must go back to absolute zero to find positive lack of heat. However, we have arbitrarily classed treatment at above room temperature as heat treatment and that below zero Fahrenheit as sub-zero or cold treatment.

The subjection of metals to temperatures below zero has been found beneficial, though in reality these are still "heat" treatments at unusual temperature ranges and subject to the same laws as govern treatment at hundreds of degrees above zero, which makes the subject more understandable.

The wearing qualities and life of high speed tool steel and other high quality alloy steels have been lengthened, perhaps from 10 to 300% (though many claim the last figure is exaggerated and merely represents correction of improper heat treatment) by sub-zero treatment. There is more agreement on the stabilization of gages by the treatment, each heat and chill being equivalent to a summer and winter of natural aging. In both cases of the above, untransformed austenite is changed to martensite, a bulkier constituent. Where gages are made of green steel nature gradually makes this change, swelling the gage and making it inaccurate.

Whereas in gage steel rapid aging is desired, in certain aluminum alloy items, such as rivets and sheets, it is desired to postpone aging because of the hardening that ensues. Hence rivets, sheets and other such items are frequently refrigerated to hold the original soft condition for a few hours or days, pending fabrication.

A mere mechanical service performed by sub-zero treatment is shrinking of a male part prior to mating. In its contracted state it is inserted, becoming tight and permanent at room temperature. Often a supplemental operation consists of simultaneously heating mildly the mating part to expand it. Such shrink fits are superior in several ways. There are no marks, mars, distortion, etc., such as occur often in press fits.

Refrigeration is being used successfully on certain electrodes in welding, chief benefits being long intervals between dressing of electrodes. Cooling of cutting oils, drawing compounds, etc. scarcely come under head of refrigeration because of mildly cool conditions involved, yet border on it. Closer control of operations during war time have placed more emphasis on such cooling to hold liquids under close tolerances. In the manufacture of G-1 rifle barrels at Springfield the quenching oil is kept constant within 8 F.

Furnaces, Refractories and Accessories

by M. H. MAWHINNEY, Consulting Engineer, Salem, Ohio

An eminent combustion authority has recently remarked that the frequent reversion to principles and practices once considered obsolete is one of the peculiarities which causes furnace design to be endlessly interesting. This truth can be illustrated by very recent developments.

About 1920 the fuel fired furnace development was spurred by the introduction of the clean, quiet, and uniform resistance type of electric heating furnace. Similarly, the fuel fired furnace industry is being strongly affected again by the recent introduction of electric induction heating. By this method, metal parts can be heated for forming or for heat treatment in exceedingly short times, with a minimum amount of oxidation or surface decarburization resulting. To compete with this development, the old law of heat transfer by radiation (Stefan-Bolzman Fourth Power Law) has been re-examined and applied, with interesting, if not entirely amazing, results by those directly interested in fuel-firing.

The result is a new type of heating (sometimes referred to as "patterned combustion," "hell-hole heating," etc.), which consists in developing a high rate of complete combustion in a very small chamber; chunky pieces are heated in batch manner or rods and bars are heated continuously. The high combustion rates are maintained by carefully premixing fuel and air, and the rapid heating is accomplished by using a high temperature head in the chamber, to a degree where the time required is entirely a matter of heat conduction within the heated piece.

Compared with usual heating practice, this newly proposed method will comprise a large number of very small chambers at very high temperatures and with accurate timing regulation, as compared with one or two standard furnaces at lower temperature and with less emphasis on time of exposure. The outstanding advantage of the method is the short time of exposure to heat, and the disadvantages include higher fuel consumption (caused by high flue gas losses) and overheating if time is not accurately controlled.

The method has been highly successful in a number of special applications to date, and, with some possible revision, will probably be extended to many other heating requirements. For example, in the heating of billets to reduce decarburization and other surface damage, the method of using two furnaces, one for preheating under 1600 F and the other for finishing at high rates in a small furnace, has already been applied with success.

This development of two furnaces has also revived the old-fashioned refractory walking beam furnace, once virtually abandoned, because it is ideal for handling heavy pieces continuously at intermediate temperatures where atmosphere control is not very important. This is another example of the fact that no method or design should be entirely condemned in the ever-interesting business of industrial furnaces.

Salt Bath Treatment

by HAIG SOLAKIAN, A. F. Holden Co., New Haven, Conn.

Some of the outstanding recent developments in the application of salt baths for heat treatment of metals may be mentioned briefly as: (1) The use of radiation pyrometers; (2) the use of ceramic pots; (3) the practice of "Demetalizing"; (4) isothermal or flow heat treatments; (5) automatic conveyor set-ups; and (6) nitriding in salt baths.

Radiation Pyrometers: In this technique the radiation energy focused on a lens is utilized to register and control the temperature. A target is allowed to sight upon the molten bath, and the radiation through the target is focused by the lens directly exposed. This has a distinct advantage of recording and controlling the temperature without any lag and accurately.

Ceramic Pots: Such pots, internally heated by electrodes, last for months. They permit keeping the bath free from metallic oxides which normally caused decarburization and soft skin, and have other advantages.

Demetalizing: In the heat treatment of certain tool steels decarburization is a serious difficulty and often is aided and abetted by metallic oxides. These are introduced into the bath by the fixtures, baskets, electrodes and by the tools themselves. A method has been developed which removes these metallic oxides by passing a current thru the bath and depositing them on a cathode. (This is covered by Patent No. 2,349,767.)

Isothermal or Flow Heat Treatment: Very often certain parts made of alloy steels are finished to close tolerances, and need to be heat treated to a definite specification as to hardness and physical strength with minimum distortion. Instead of the conventional method, such parts are treated by heating them to the hardening temperature, then transferring to another bath at a lower temperature where they transform at a constant temperature rather than through a quench-and-temper as normally. In either case the temperature to be selected depends upon the physicals desired. Constant temperature transformation involves a minimum of distortion, and often gives improved properties. It is increasingly used for pre-use treatment of intricate parts.

Automatic Conveyors: Heretofore, pot furnaces have been used only for batch type of work. Recently, pot furnaces have been designed and built with automatic conveyor mechanisms. Fixtures carrying the work go thru the various baths, are held here for a predetermined period of time, and then unload automatically. Such a unit recently built handles 2000 pieces per hour.

Nitriding: Pot type furnaces with special baths have been developed for the nitriding of steels. In this process a nitrided depth of 0.010 in. in 8 hrs., 0.015 in. in 15 hrs. and 0.020 in. in 30 hrs., may be expected.

Controlled Atmospheres

by NORBERT K. KOEBEL, Lindberg Engineering Company, Chicago, Ill.

The chief advancement made in controlled atmospheres is in the design of the equipment to meet the fundamental requirements of a protective atmosphere with a sense of economy, efficiency, and simplicity of operation. The fundamental requirements of a protective atmosphere for scale-free hardening of medium and high carbon steel totally free from decarburization are that the carbon dioxide and water vapor constituents must be either completely removed or reduced and controlled at very low percentages, depending upon the alloy and carbon contents of the steel to be treated.

To meet this end, most of the equipment has been designed around either one of the two following methods: The first method makes use of charcoal to produce a gas low or free of carbon dioxide, low or free of water vapor, and high in carbon monoxide and nitrogen. The second method utilizes the principle of cracking a mixture of gas and air of the proper proportion over a heated catalyst to produce a gas low or free of carbon dioxide, low or free of water vapor, and high in hydrogen, carbon monoxide, and nitrogen.

The trend in the design and also the trend in the application of charcoal gas generators will change somewhat during the coming year. The chief factor which will affect the design is the availability of an improved grade of charcoal for gas generators. With this purified grade of charcoal, a gas generator of a simple design, simple and foolproof to operate, low in maintenance, and costing but one-fourth as much as the externally heated type can now be used to achieve the same results. This will put precision atmosphere control within reach of the small tool shop that could not before afford it.

In the future, however, the charcoal type of generator will not be applied to furnaces for the production heat treatment of medium and high carbon steels in same way as they have been in the past. The chief reason for this is the handling and storage space required for charcoal to produce large volumes of gas for large furnaces.

The so-called endothermic gas cracking generator, which comes under the second method above, is now being perfected to a stage where all production high carbon steels can now be handled successfully. The charcoal gas generator, however, will still be used for tool room furnaces because of the low initial cost, plus the very important factor that the charcoal gas is more foolproof to use in the heat treatment of the tool steels prone to decarburization.

Recent months have produced some interesting developments in the use of atmospheres for bright gas quenching of air hardening steels, for "gas pickling" and for restoring carbon to steel surfaces decarburized during hot working operations, and of partly-burned fuel gases containing lithium as an internal purge. Special wartime requirements for stainless steels and other high alloy materials have increased the use of dry hydrogen, nitrogen and dissociated ammonia for strictly protective purposes.

Carburizing

by J. H. HEATH, Hyatt Bearings Div., G. M. Corp., Harrison, N. J.

Carburizing practice has taken a decided step forward during the past decade. It can well be remembered by our more mature metallurgists when it was the practice to obtain ingredients such as raw bone, charred leather, charcoal, and coke, mix it to what seemed to be a desirable proportion, pack into cast steel containers, charge into batch type furnaces, and be quite satisfied with the questionable results.

During the following ten years some progress was made, which consisted of the production of a commercial carburizing compound made up of hardwood charcoal, coke with a chemical energizer, such as barium or sodium carbonate. The old cast steel pots were replaced by pots or boxes, cast or fabricated from heat resisting alloy, and the batch type furnaces were replaced by continuous furnaces, some full flow and some counter flow, depending upon whether you required a quenched or slowly cooled product.

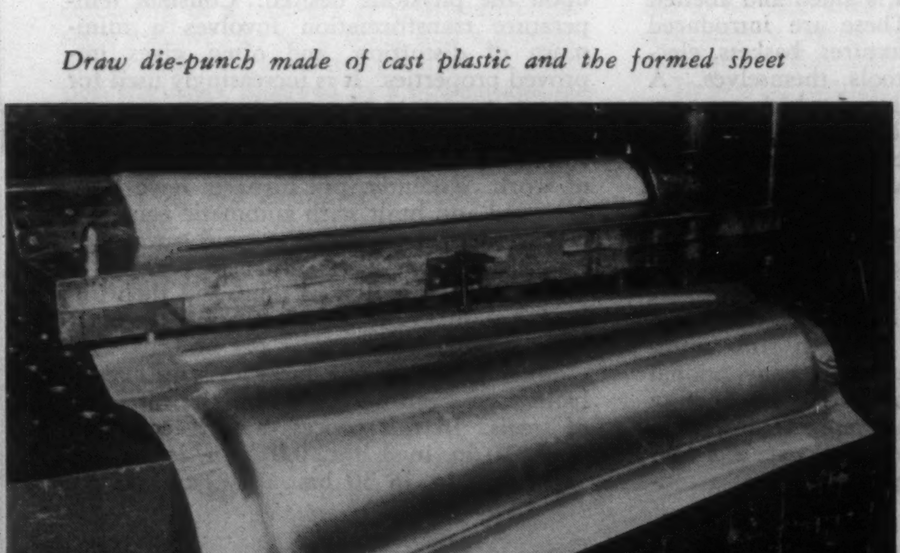
Some attempt was made to control carbon concentration by the addition of some of the used carburizing compound and the reduction of temperatures at the discharge section of the continuous furnaces.

During the early thirties, gas carburizing had passed through the laboratory stage and was accepted for commercial application. This step was, perhaps, one of the greatest in carburizing history. The furnace builders were quick to commercialize on the new method, and designed continuous type furnaces with large expensive muffles, with varying numbers of gas inlets, some top, some bottom, and some at the sides of the furnaces. At the same time it was recognized that a sooty or dirty condition of the carburized product, and furnace, was resulting, necessitating some expense to clean the product and short shutdown periods, with interruption of the production flow, for cleaning the accumulated carbon deposit in the furnaces. A forward step was taken to obtain a cleaner product by cracking gas mixed with varying portions of air, mixing same with some raw gas just before entering the muffle. At about the same time some furnace manufacturers introduced the circulating fan type pit furnace, with fans installed in the top cover, or at the bottom. Some of the pit type fan circulating furnaces used liquid carburizing agents, and some gas.

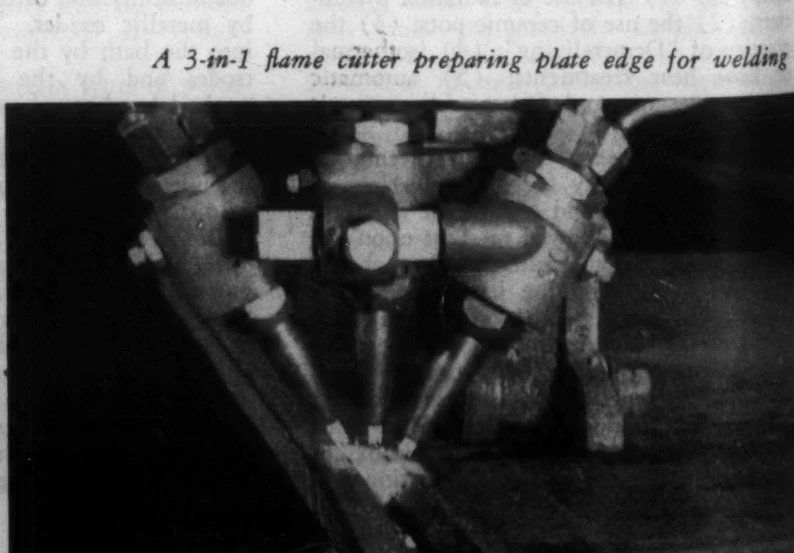
During all this development in carburizing practice, through the last decade, very little attention was given to the percentage of carbon obtained in the carburized case. In the writer's opinion, this important phase of carburizing has been neglected. Some control has been obtained by diffusion, but consistent results are not possible with this expensive practice. A close study of surface area to be carburized, in relation to the quantity of carburizing media, has in some cases produced the desired result. It is to be understood also, that temperature, although capable of playing an important part in concentration, is held to a recognized standard.

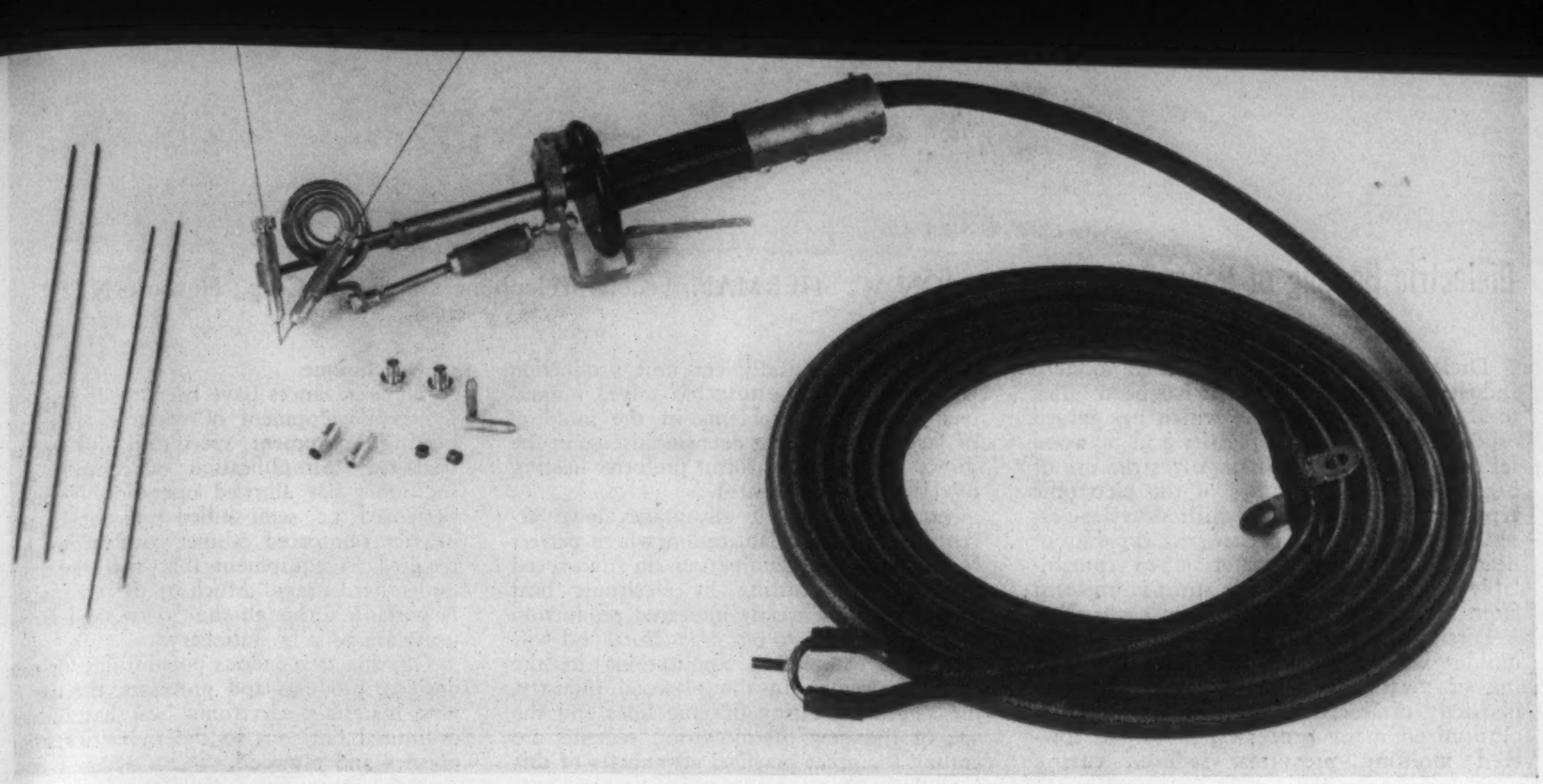
Due to expected post-war economies, it may be necessary to take advantage of all economical possibilities, and increase the applications of carburizing steels. We also are aware of the danger of high carbon concentration in carburized sections, because of the brittleness encountered when a matrix of iron carbide forms in the grain boundaries. This carbon control is important in bearing applications and other highly stressed parts where a combination of hard wearing surfaces and toughness is required. Therefore, the economies to be gained in carburizing practice will be the development of a simplified method of carbon control, and any research for post-war planning should be concentrated in this direction.

Draw die-punch made of cast plastic and the formed sheet



A 3-in-1 flame cutter preparing plate edge for welding





A recently developed atomic hydrogen arc welding electrode holder (50 amps., for 0.040, 1/16 and 3/32 in. electrodes)

Nitriding

by ROGER J. METZLER, Breeze Corps., Newark, N. J.

The story of Nitralloy steel and the nitriding process has been covered in print adequately and often. We know well the high hardness and wear resistance, the clean "as-hardened" surface and the low distortion of this type of case hardening. In recent years the trend of improvement has been toward changes in the process rather than the materials.

One of these developments has been the surface hardening of stainless steels, both the straight chromium and chromium-nickel types, by heating in a nitrogen atmosphere. Requirements of war production have focused attention on another development, the nitriding of high speed steel tools. Finally, a recent technical report has given the users of Nitralloy another method—a means of saving quantities of ammonia by a slight change in the process.

The surface hardening of stainless steel is quite similar to the standard nitriding process. In regular nitriding procedures, the ammonia is cracked in the heating chamber where the hardening takes place. In nitriding stainless steels, before the gas reaches the hardening chamber, it is cracked to nascent nitrogen by ionization. Instrument and aircraft industries should prove to be big users of this high hardness, wear resistant, corrosion resistant material.

The nitriding of high speed steel is not a truly new process but has come into general use only in recent years. By heating fully hardened high speed steel tools at a temperature in the range of 1000 to 1100 F in a properly prepared cyanide bath, extremely light nitrided cases are produced.

Nitriding of tool steel is best accomplished by the salt bath method because the hardening is slightly inhibited by the presence of carbon. The failure of dry nitriding of high speed steel is traced to the excessive amount of nascent nitrogen present during the reaction.

Recently C. A. Floe presented a technical paper describing a process for saving large quantities of ammonia. The variation of the standard process described was an increase in the dissociation of ammonia. In the standard procedure a dissociation of 30% is recommended, while Floe describes excellent results achieved at 85% dissociation.

The most satisfactory case was achieved by nitriding at 30% dissociation for a short period and then allowing the dissociation to increase to 85% for the balance of the nitriding period. There was no decrease in the usual depth of case and the usual white layer was practically absent. The advantage of this development is self-evident. Increased dissociation enables the user to effect a saving in ammonia not believed possible.

Induction Heating

by FRANK T. CHESTNUT, Ajax Electrothermic Corp., Trenton, N. J.

It may be of interest to point out at the start of this review of induction heating that the commercial process will this year be nearly 30 years of age, and that the author's company, founded in 1920 to exploit the invention is now celebrating the 25th anniversary of its founding. It seems hardly possible that the method of heating represented by the little spark gap furnace invented by the late Dr. Edwin F. Northrup during the first World War would develop to be as important a factor in production for the second World War as it actually has become.

Melting, forging and hardening have been the operations most affected, with brazing, soldering, annealing and a host of other applications following close behind. With war-born impetus the method is reaching into an ever-widening field in what will some day be our peace-time industry. Reconversion of induction heating equipment, indeed, will require an absolute minimum of readjustment.

For example, melting operations for war or peace are not greatly different. More special alloys, larger volumes and the like mean only additional capacity or more flexible switching arrangements. Equipment for making emergency castings behind the battle lines has had to be more rugged and mobile but will serve as well in any small peacetime foundry. The induction melting equipment for the big centrifugally cast gun installations can be used for ingots or castings as well as for guns, while the electrical equipment can be adapted as desired for forging or other heating applications. Similarly most hardening and brazing installations can be easily transferred from a wartime to a peacetime use.

Interest in electronic tube equipment has continued to grow, especially for small part heating and for the hardening of parts to very thin layers. A typical application is the exact contour hardening of the teeth on a small inner gear for supercharger clutch discs, done to a depth of 0.050 in. in a fraction of a second per gear. The trend in electronic units is toward higher power ratings; during the year one manufacturer introduced a standard 50-kw. unit while another announced a versatile hookup of two 20-kw. units that can be operated together or separately as desired.

Motor-generator sets continue to represent the bulk of installed power for high-frequency heating and melting. A typical automatic heating set-up hardens the 103 teeth on an 82-in. ring gear, one tooth at a time, in less than 18 min.; the method formerly used took seven times as long. Heating seamless tube for forming bombs or cylinders, or bar stock for forming shells or automotive parts, and the combined surface hardening and shrink-fitting of tractor rollers are other interesting wartime jobs that this type of induction heating has successfully accomplished.

The spark gap converter type of equipment covers a wide range of applications and finds new friends because of its middle-range frequencies, its sturdiness for many of its higher-frequency applications and its extreme versatility and adaptability.

Dielectric Heating of Nonmetals

by VERNON W. SHERMAN, Federal Telephone and Radio Corp., Newark, N. J.

Dielectric heating has provided modern industry with a tool which it has been quick to accept and exploit, and which has gained especial recognition in plastics and plywood fabrication. The process involves the use of high-frequency convertors of the electronic type for producing multi-million cycles-per-sec. electrostatic field changes, capable of heating nonmetallic materials to controllable temperatures. The heating is uniform from the center to the surface of each piece.

Particularly invaluable to the plastics molder because of thorough uniform heating of plastic preforms and the complete plasticity produced, electronic heat has revolutionized many processes, permitted lowered molding pressures, reduced curing times, and drastically cut unit production costs. Dielectric heating has solved numerous production problems in the molding of large parts and in deep molds, again the direct result of uniform preform heating by electronic equipment.

Equally important advantages have accrued in plywood fabrication where perfect resin-bonding of laminations in high-speed continuous processing by electronic heat has resulted in greatly increased production of material vital to our war effort, and will find ever increasing applications in the peace to come. In the plywood industry, the selective heating of glue lines and the use of the new thermosetting cements are among the great practical advantages of this new technique.

These advances have been made possible by the development of versatile electronic heating equipment specifically for industrial use. Simplification of controls and indicators has allowed operation by inexperienced or semi-skilled personnel, and heavier reinforced cabinet construction has resulted in equipment that will stand up under hard usage. Much of the equipment is portable although the 50-kw. and larger units are usually stationary.

Offering tremendous possibilities for new designs, products and processes, the use of new materials, electronic heat has opened unlimited horizons to the industries using plastics and plywood.

Flame Hardening

by KENNETH ROSE, Engineering Editor, METALS AND ALLOYS

Progress in flame hardening during 1944 has brought many refinements to existing equipment, and several adaptations of techniques to new processes. Full advantage is being taken of the applicability of the method to large pieces of work, and battle-front-bound items too large for easy handling by other methods are being heat-treated with the oxy-acetylene flame.

Typical of this type of work is the hardening of the teeth of large ring gears. The gears, often 9 ft. in diam., are mounted in jigs that bring each tooth successively under the hardening and quenching heads. For large straight-line work, the heads are mounted on conveyors that carry them along the piece, the work itself remaining stationary.

For parts in which wear resistance requires hardness at certain sections, combined with the shock resistance of low carbon steel, carburizing has been the usual procedure. However, the cyaniding technique, with the quenching operation that follows, sometimes causes distortion of the work. It has been found possible to carburize such pieces and to flame-harden the proper areas without distortion, thus avoiding the necessity for stopping-off the non-hardening areas with copper.

Larger areas have been flame-hardened than was possible formerly. Shortages of manganese for steel for railroad switch frogs has led to the use of plain carbon steel, flame-hardened on the wearing surfaces. Cast irons of good quality have been successfully flame-hardened, as well as the alloy cast irons and the inoculated cast irons that have been so widely used in war production.

With the application of flame hardening to more exacting heat treatments, more accurate controls have become necessary for the machines. Electric controls for the turntable, with push-button starting and limit switches, have become a part of many machines. Temperature, time of application of heat, and resulting depth of heating are closely regulated. Quenching is usually done with water jets, with a mist of water formed by compressed air, or with compressed air jets alone. Oil is also used as a quenching medium. Quenching is controlled so that the proper draw succeeds it.

For many operations heating, quenching and drawing can take place in one operation. Heating and quenching heads can be mounted separately. To obtain high production multiple heads may be used, and several pieces of the same kind may be stacked and heat-treated together.

Brazing

by A. N. KUGLER, Air Reduction Sales Co., New York

Applications of brazing may be found in virtually all phases of war production and many will be carried on over to peace time manufacturing.

The spelter of former years finds but limited use today but in a new form it is the braze welding (sometimes called bronze welding) rod of today—an invaluable tool in maintenance and production. Whereas brazing requires the lap or shear type joint for best results, braze welding uses the butt joint (either square or vee groove) to achieve strengths that equal those of mild steel.

Modern brazing is performed with alloys melting at lower temperatures than spelter. These new analyses usually involve silver in combination with one or more elements such as copper, zinc, cadmium, nickel, phosphorus, etc.; other alloys are based upon additions to copper such as phosphorus. Contrast the melting points of spelter, ranging from 1650 F upward, with those of these modern alloys which show a range of 1175 to 1600 F. Even aluminum and many of its alloys may be brazed by the modern alloys by selecting alloys of suitable melting points below the values of the alloys which are to be joined. A flux of proper flow point is necessary for success.

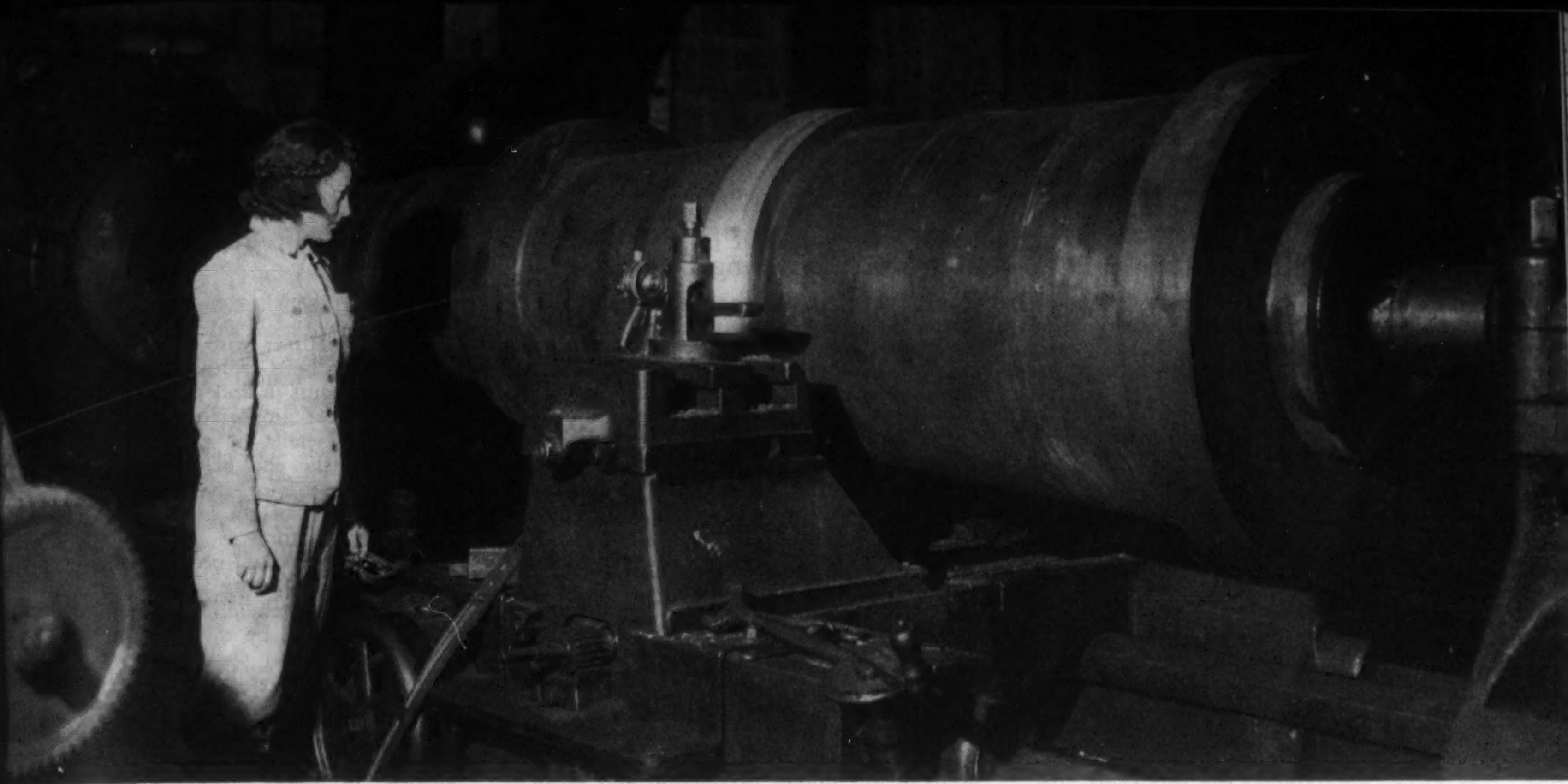
While feeding of the alloy by hand to the heated joint area produces eminently satisfactory results, the high production requirements of today have extended the use of a technique known as preplacement of the alloy. This simply means that following cleaning and fluxing of the parts the alloy, in appropriate form, is placed in the joint area at the time of assembly. While the particular joint design dictates the form of alloy for placement, some of the more common methods are by rings, washers, strips, shaped wires or slugs.

The correct amount of metal is determined either experimentally or by calculation. The placement of this alloy must be such that it is remote from the point of heat application, yet touching the joint in as many places as possible. When the heat is applied and the alloy melted it flows by capillary action towards the source of heat, running into every crevice of the joint. The high fluidity of this molten alloy makes it particularly suitable for this work.

The method of heating employed with this procedure is largely governed by the metals involved, the production required and the usual economic factors. Oxyacetylene flame heating may be used in hand held torches or in fixed torches which play upon jig held work. The intense heat of this flame makes it undesirable on some assemblies where it is desired to limit the heating but it proves advantageous on metals of high conductivity.

Oxygen in combination with other fuel gases or compressed air with these gases are also used. These may be utilized much the same as the oxyacetylene flame but do not create the same conditions of overheating. Of particular interest is the combination of oxygen and city gas under positive pressure (up to 10 p.s.i.).

Another arrangement for high production work is the ceramic burners using premixed city gas and compressed air. Furnaces of various types, operating on batch loading or continuously, offer still another means of heating. For those metals and assemblies which permit of its use, induction heating provides many possibilities for production brazing. Still another means of heating is provided in molten salt baths.



Building up the surface of an outsize centrifugal-mold bearing by metallizing it with molten iron

Hard Surfacing

by R. L. LERCH, Haynes Stellite Co., Kokomo, Ind.

The hard-facing process has gained increased recognition during the past year—with wartime demands emphasizing the necessity for maximum wear from new parts and the reclamation wherever possible of worn parts. Many new applications have been tried and found successful, and former applications are finding increased use in practically every industry.

For instance, valves of many types are being hard-faced with Stellite and similar alloys for longer, more economical, life. Practically all airplane motors and a great many other heavy-duty internal-combustion engines in use today are fitted with hard-faced valves. Gate and globe valves and other types for handling high-pressure, high-temperature steam are regularly hard-faced. Refinery valves used in the production of aviation gasoline, oilfield flow-control and mud valves, and others in many industries are also hard-faced.

Hard-facing welding rod has continued to prove its worth in repairing manganese steel parts and in reconditioning gyratory crusher mantles, dipper teeth, and other parts subject to severe impact. Cast tungsten carbide inserts and tube rod have helped oil well drillers get maximum round-trip footage and out-to-gage holes from their drilling tools; this application has assumed added importance with the increased drilling activity during the past year.

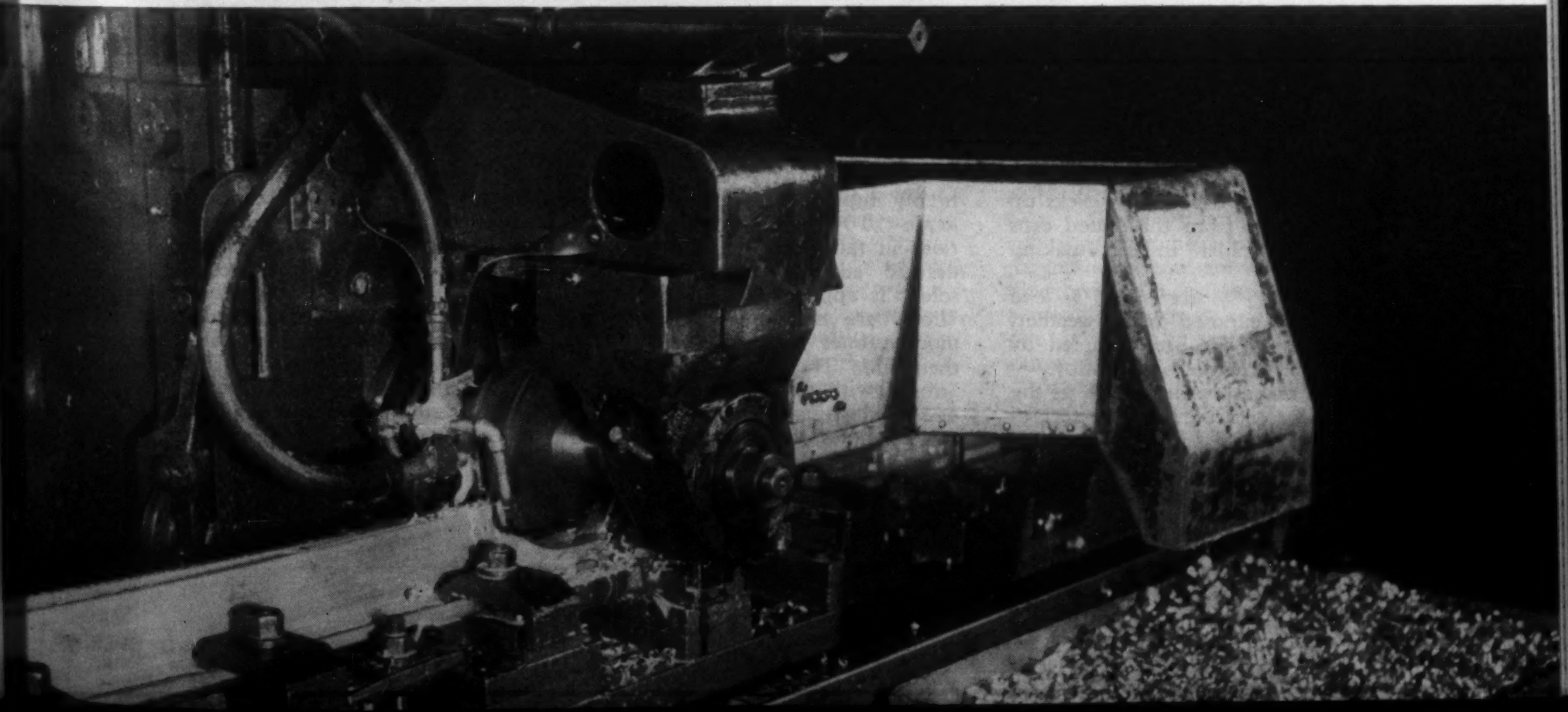
The use of a combination of hard-facing alloys—say tungsten carbide for one area and Stellite for another—to meet a wear problem has also increased in favor.

Nickel-base alloys like Hastelloy have recently proved to have outstanding advantages on applications requiring resistance to wear combined with heat and thermal shock. It has the great advantage of machinability—parts hard-faced with this alloy can easily be machined instead of ground. A nickel-molybdenum-chromium-iron rod has done a noteworthy job on facing punches used on 75-mm. shells, where the punches had to withstand a thermal shock after each use. A punch hard-faced with this rod produced 2,000 shells, and was buffed after every 500 shells to improve the piercing action. The previously used tool steel punch produced only 450 shells and had to be buffed every 150 shells.

This alloy also proved equally successful on a forming and piercing punch and die for forging bomb booster caps. Another type of rod, a nickel-molybdenum-iron alloy, has been used on new and used plug valves for aviation gasoline plants and other refinery equipment where heat and corrosion made ordinary valves uneconomical.

Large production requirements have made it increasingly desirable to mechanize some phases of the hard-facing process. In addition to the rotating units or jigs, table rests, and other devices which have been used in the past to speed up hard-facing, automatic hard-facing machines have been devised for applications requiring uniform hard-faced parts in quantities large enough to warrant the manufacture of these machines.

An air-duct system on this machine removes the chips from the milling cutters and deposits them in the scrap container



Gas Welding, Cutting, Etc. by EDWIN F. CONE, Consulting Editor, METALS AND ALLOYS

While the welding of heavy sheet steel has been done largely by the electric arc or by machine welding, 1944 saw the development of a new process in gas welding that will become a factor in this field. This is pressure welding, sometimes called solid-phase welding. In this technique the abutting edges are carefully fitted up, smoothed, and butted under pressure. Welding flames then heat the metal to a temperature below fusion, about 2200 F. Pressure is increased, and the parts are forced together, completing the weld.

An important feature of this new welding process is that the metals being joined are not fused. The hot metal is pressed into union at a temperature probably 500 deg. below its melting point. Smooth edges are a necessary requirement for this procedure.

The gas flame was adapted to a new type of stress relieving for welds, in which heat is used only to cause expansion of the metal adjacent to the weld. The thermal expansion is produced parallel to the line of the weld, and results in a stress relaxation in the weld zone. This is referred to as low temperature stress relieving, since temperatures reached in the metal are about 400 F.

Flame cutting has done valiant service in the shipyards, although its achievements have tended to be overlooked because of the more spectacular nature of arc welding. The cutting and scarfing of steel plates is quite as necessary and as important as the joining of those plates in the hull of the vessel. Flame cutting has been similarly useful in other industries, with an increasing tendency to mechanize the process so as to obtain higher production and greater precision. Cutting machines with multiple burners, sometimes with electronic guiding devices, have been typical of this trend.

Developments in underwater torches have been of great importance to the armed forces, but details of these must remain secret until the end of the war. Progress in flame cutting of steel billets has permitted the use of the process for heavier sections than before.

Gas welding has been especially important in fabricating light gage metal, because of the generally better control of the heat possible by this method. Newer, more accurate and steady generators have permitted the electric arc to offer a challenge in this field. However, the oxyacetylene and other gas flames still have fields in which they are alone, as in lead burning, or have a decided edge, as in welding of many nonferrous metals.

Arc Welding by CHARLES H. JENNINGS, Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

Arc welding has been utilized on almost every type of equipment since the start of the war, consequently, it is a little difficult to find fields of application where it has never been employed. The extensive use of this fabricating process, however, has only served to encourage new developments and to find ways of improving existing applications.

Automatic welding continues to hold a leading position as a method of reducing costs and improving weld quality. The many advantages of automatic welding as demonstrated on pressure vessels, ships, machinery and general construction work is resulting in its application to many products and structures which were not considered adaptable to automatic welding several years ago. Developments in this field have also extended the application of this process to low and medium alloy steels, stainless steels and hard facing applications.

Recent developments in arc welding electrodes are following the general trends toward a.c. welding. New all-position type electrodes for use with alternating current are capable of producing horizontal, vertical and overhead welds of a quality equal in every respect to those made with direct current. Stainless steel, low alloy and hard facing electrodes for use with a.c. have also been developed in increasing numbers.

Another advancement in the a.c. welding field is high frequency stabilized welding machines. This equipment makes possible the use of alternating current to weld nonferrous metals and special alloys for which a.c. stabilized electrodes are not available, and opens up the light-gage metal field where extremely low currents are required.

Arc welding of light metals by using inert gas sheaths has found many new applications. The outstanding merits of this welding process are resulting in its use on many special alloys and metals. Both manual and automatic welding applications for this process will expand rapidly within the next few years.

The importance of arc welding as a repair tool is being realized more than ever by many companies who are employing it to repair broken tools. Necessity during the war caused many cutting tools to be repaired but the success of this repair process has been so great, from the standpoint of the service life rendered and the money and time saved, that no doubt arc welding is going to continue to play a greater part not only in the repair of broken cutting tools but in the fabrication of new tools.

Soft Soldering by G. O. HIERS, National Lead Co., Brooklyn, N. Y.

The tin scarcity has resulted in the economic use of sizable quantities of solders containing 93 to 99% lead, 0 to 2.5% silver and 0 to 5% tin. As a result of producer research and user experience, exact formulation of the alloys for best performance has been found highly desirable. A 2½% silver-97½% lead alloy picks up as much as 5% tin from tin coated cans when used as a solder in can making machines.

In the use of 2½% silver-97½% lead for soldered seams exposed to the weather, destructive corrosion has been avoided by the inclusion of tin in the solder alloy.

The use of a modern process such as the Kolene process for decarburizing the surface of cast iron has made possible good soldering to this metal. Proper fluxing when soldering is always essential and intensive studies of fluxes have brought forth the adoption of wetting agents in modern fluxes. By such means better soldering through better wetting of metal (to be soldered) with solder is accomplished. Modern solder wire procurable with flux on or near the surface facilitates good soldering.

Soldering in the electrical industry is highly important. Sustained usage of high grade 50-50 solder for electrical connections in radio sets and apparatus has been deemed advisable particularly when the solder is applied with hand "irons." The "irons" are made of copper and sometimes modern ones are iron coated to prolong their life. The use of electrically heated "irons" with variable voltage transformers or suitable resister units in the heating circuit promotes efficiency by preventing overheating when the irons are not in actual use but kept in stand-by heated condition.

Joints in lead-sheathed electric cables are now made with a tighter wipe on sheath to sleeve joints with a considerable saving in solder consumption. Lead welding for such purposes and for joints for lead pipe water conveyors has been resorted to with some success but complete replacement of solder wiped joints is highly improbable.

Two types of heating for soldering are coming to the fore: electric induction heating and low voltage electric resistance heating with carbon electrodes.

When tin is available without restriction it is probable the standard 40 to 50 per cent tin-lead solders will be widely used. However, the solders containing 0-2.5% silver, 0-5% tin, balance lead will probably continue to be used in appreciable quantities. (An instructive article on soldering technique by Mr. A. Z. Mample, Engineer, Western Union Telegraph Co., will appear in a future issue of METALS AND ALLOYS.)

Atomic-Hydrogen Arc Welding

by R. F. WYER, General Electric Co., Schenectady, N. Y.

For difficult welding jobs, where the design of a joint for metal arc welding presents serious problems, atomic-hydrogen arc welding has been increasingly investigated and applied. A gas-shielded arc process, the general characteristics of atomic-hydrogen arc welding fall somewhere between those of metal arc welding and oxy-gas welding, combining some of the characteristics of both. It is faster than gas, and, except on very thin materials, slower than metal arc.

In flexibility of manipulation it is similar to gas welding. As in gas welding, the rate of the addition of filler rod can be controlled independently of the amount of heat applied to the joint. Filler metal can frequently be introduced into the joint by means of a strip or upstanding edge incorporated into the joint preparation.

The atomic-hydrogen arc has very strong reducing properties, since it is surrounded by very hot, atomic-hydrogen. Frequently this eliminates the necessity of fluxes. It results in extremely clean welds, both on the top and bottom surfaces as well as in the fused metal. The force of the jets of hydrogen gas which envelop the arc is extremely light. Consequently there is very little tendency to blow holes in thin work.

A recently developed electrode holder, characterized by light weight and small over-all dimensions extends the application of the process to relatively inaccessible joints. Automatic equipment, wherein the proper arc length is maintained by an electronically controlled motor, permits machine welding at high duty factors and with maximum consistency of results. Such automatic equipments are available with one arc, or with several arcs operating in tandem for greater welding speed and for extension of preheating and post-heating zones characteristic of the single atomic-hydrogen arc.

The usual field of applications for atomic-hydrogen arc welding lies in those joints which do not require the addition of large amounts of filler metal, those for which filler metal of the proper characteristics is not available in good arc welding electrodes, and joints where the very highest quality of which the base material is capable, in respect to tensile strength, ductility, and soundness, is required.

Typical recent applications include machine welding of stainless and other alloy tubing, fabrication of aircraft propeller blades, Navy anchor chains, pressure accumulators, and oxygen breathing tanks for aircraft crews.

Resistance Welding

by WENDELL F. HESS, Rensselaer Polytechnic Institute, Troy, N. Y.

The most significant recent developments in resistance welding have taken place in the following fields: (1) The spot welding of light alloys for aircraft fabrication; and (2) the spot welding of light gages of hardenable steels.

In the spot welding of light alloys for aircraft fabrication, three important developments should be noted. The first of these is the improved performance of welding machines of the stored energy type making it easier to produce sound welds with a higher degree of consistency. Other machine improvements have led to easier maintenance and higher operating speeds.

A second direction in which improvement of spot welding has taken place involves the surface preparation of aluminum alloys for spot welding. These alloys are ordinarily received from the mill with a surface layer of oxide which interferes with the proper distribution of spot welding current. Investigations show that the best welds are always produced when the surface contact resistances are of low magnitude.

Research has developed satisfactory methods for the measurement of surface contact resistance and these have almost universally been adopted by the aircraft industry as a means of evaluating the satisfactoriness of spot weld cleaning solutions. New solutions for the surface preparation of aluminum alloys for spot welding have been developed which combine the advantages of room temperature operation, non-critical immersion time, and very much lower cost than other cleaning solutions.

The third direction in which significant improvement in the spot welding of light alloys has taken place is in the development and use of methods for the control of quality of spot welding in production. These techniques involve the measurement of surface contact resistance, and in addition make use of oscillographic techniques for investigating the satisfactory operation of the resistance welding machine.

The oscillographic techniques for the simultaneous measurement of pressure and current have been instrumental in showing conclusively the advantage of the double pressure system in the spot welding of present aluminum aircraft alloys, sufficiently to warrant the introduction of spot welding into the primary structures of aircraft.

The second major field of development of resistance welding mentioned above was the spot welding of light gages of hardenable steels. Ordinary spot welding methods may not be satisfactorily employed to weld the wear resistant medium carbon steels and the corrosion resistant alloy steels. A process of making tempered and thereby tougher spot welds in hardenable steels has been developed, and involves automatic tempering within the welding machine by adding to the ordinary spot welding current and time controls, an additional timing interval for quenching and a third timing interval for tempering, with appropriate current control for this purpose.

Maximum toughness may be obtained by heating to the highest possible temperature below that required to reharden the metal. Recent investigations in this field have extended the use of the tempered spot weld process to aircraft steels and to a variety of plain carbon steels. The results of these investigations have been of immense value to several important military and essential civilian applications.

Adhesive Bonding

by KENNETH ROSE, Engineering Editor, METALS AND ALLOYS

Adhesive joining of metals, accomplished several years ago by the Cyclewelding and Reanite bonding materials, continues to be an important procedure in the aircraft industry. Several new adhesives have been added to the list of those tested and accepted for use in the manufacture of military aircraft. Consolidated Vultee Aircraft Corp. is now using its Metlbond in the building of the Liberator bomber, and B. F. Goodrich has announced its Plastilock 500 for bonding of metals.

Important uses, and probably the most important future possibilities, for the new organic bonding materials lie in the field of composites, in which two or more different materials are joined together. In the construction of glider ski pedestals rubber is joined to metal so securely that the rubber itself tears before the bond fails. Metal-sheathed plywood has already gone into the construction of railway cars, for bulkheads and door panels. So-called sandwich materials, in which an inner and an outer sheet of one material, as aluminum or wood veneer, are separated by a layer of a second material, usually balsa wood, have already been outstandingly successful. The British Mosquito bomber is an example of the use of such sandwich material.

The adhesives are for the most part similar in composition. A rubber, either natural or synthetic, and a synthetic resin are combined, either beforehand or at the time of using the material, and heat and pressure during bonding "set" the adhesive.

While these new joining materials have good low-temperature strength, their resistance to elevated temperatures is for the most part limited to the range below the boiling point of water. The adhesives are offered in a range of curing temperatures and pressures, but presses and special dies are usually needed. Strengths are claimed to be higher than that for riveted construction. Materials that can be joined by the adhesives include aluminum, steel, zinc, magnesium, and most structural metals, glass, natural and synthetic rubber, wood, some of the textiles, and many plastics. No one adhesive is suitable for the entire range of materials, however.

Among the fields in which their use is predicted when manufacture of civilian goods is resumed are the building trades, furniture, automotive and railway construction, refrigerators, radios, etc.

Fastening and Riveting

by EDWIN LAIRD CADY, Contributing Editor, METALS AND ALLOYS

Accuracy of the control of fastening methods took two new twists this year. The first was the announcement by General Motors researchers that if the stressing of a bolt by turning up its nut is so controlled that this stress is superior to any shock load which operating conditions will impose upon the bolt, a much smaller bolt than ordinarily considered to be necessary may be used. The second was the announcement by Westinghouse Electric & Manufacturing Co. engineers that bolts of a given size and material can be made 40% stronger by providing broad shoulders and tapered threads—plastic models of bolts stressed under heat and then examined by polarized light revealed the patterns of stress lines which led to this discovery.

These two add up to one important conclusion. Heavier stresses are going to be held by lighter weight, smaller sized, more accurately made and installed fasteners.

Most of the threaded fastening devices depend upon thread friction to hold them against loosening under vibration. Accuracy of threads increases the dependability—and almost always the degree—of thread friction. With higher accuracies, thread friction devices become more practical.

Many variants of the thread friction principle appeared on the market. As examples, Beach Precision Products Co. has a nut slotted from sides to center in such manner that as the nut is tightened one side closes on the other causing increased thread friction; Boots Aircraft Nut Corporation has a differential thread above a normal thread, the two being separated by a spring section which closes as the bolt is tightened; Tinnerman Products Inc. has increased the thread area and thereby reduced the necessary weight of some of its speed nuts; Parker Kalon has a screw having two threads of different pitch which accordingly will pull two materials together as it is driven through both; Dardelet has a stud having normal threads on one end and Dardelet type threads on the other.

Thermo setting and other plastics are making new strides as parts assemblers learn more about their possibilities. They are applied in such ways as spinning plastic rivets while applying heat; spinning grommets and letting the heat from the friction of the spinning tool set the plastic; expanding by taper pins; squeezing and heating; and boring rivet centers nearly through to their bases, heating and inserting the rivets and then expanding them with compressed air. Many of these fasteners shrink and tighten as they cool and set. This not only tightens the assembly but also strengthens the fastening by pre-tensioning it.

E. I. du Pont de Nemours increased the holding power of explosive rivets by carrying the explosive charge further up in the shank so the rivet will expand along more of its length and fill up the hole better. Users of aluminum rivets have learned more about rapid action squeezing to keep the compacting action ahead of the work hardening troubles.

With higher accuracies and smaller cross sections has come a demand for stronger materials. Stainless steel makers are finding out how to upset this tough metal to extents formerly considered impossible, and accordingly it is appearing in more fasteners. Swaging is used to increase strength on small diameters; in one case it increased the tensile strength of a small diameter stainless steel fastener from the normal 90,000 pounds up to 115,000 pounds. And this is a typical example of the present trend toward fasteners which can be smaller in size and lighter in weight because they are more carefully made and installed.

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Finishing train of an 80-in. continuous hot strip steel mill

Pickling and Acid Cleaning

by F. P. SPRUANCE, American Chemical Paint Co., Ambler, Pa.

The production of war materiel in plants that had no previous experience with pickling would have imposed a hardship upon many, had not the very general use of durable, effective and heat stable inhibitors prevented unskilled picklers, in this emergency, over-pickling and ruining the large quantities of expensive and badly needed material they did in the last one.

Except for the general use of inhibitors, there have been no recent changes of significance made in the acid pickling process in steel mills. There have, however, been minor changes that are worthy of notice. For example, the addition of ten to twenty pounds of rock salt to each hundred gallons of the usual sulfuric acid pickle, along with the small quantities of an appropriate inhibitor, has very markedly improved the pickling of some of the hard-to-pickle alloys. Metal loss and pitting are less in such baths than they are with salt alone, or with inhibitor alone, and the finely etched surface provides good tooth either for grease or powdered lubricants.

While sulfuric acid is still most generally used in mill pickling, muriatic acid alone or in combination with sulfuric acid and at times nitric acid, is being used with good results on the specific pickling problems presented in the fabrication of war materiel. Inhibitors prepared specifically for use with muriatic acid are as important as they are for sulfuric acid pickling.

An interesting trend is the use of the pickling type of cleaner (like "Deoxidine") that utilizes phosphoric acid instead of sulfuric or muriatic acid for the removal of oil and annealing scale, as well as rust.

While such cleaners used in heated solutions rapidly remove rust and light scale, they are not as effective for the removal of tight roll scale as sulfuric acid. On the other hand, the phosphate residues on Deoxidine-cleaned steel, in contrast to the rust-stimulating chloride or sulfate residues, result in better paint life and protection.

The rinsing of pickled surfaces is worthy of consideration for, with acid cleaning and to an even greater extent for work cleaned with alkalies, durable paint films require that the final hot rinse contain a non-hygroscopic, non-rust stimulating acid that will leave the metal surface slightly acid rather than neutral or alkaline.

There is a growing interest in the use of acid rather than alkaline detergents, particularly in preparation for painting, and it is likely this field will be exploited more completely in the post-war period.

Degreasing and Metal Washing

by G. W. WALTER, Detrex Corp., Detroit

During the past few months, many types of metal cleaning machines have been designed which were intended primarily for the cleaning of products required for armament purposes. In many instances, however, engineering work has incorporated features to facilitate reconversion to peace-time production quickly and at a minimum cost. In some instances, the machines are so planned that no change of any kind is required.

It is noteworthy that in the design of solvent vapor degreasing equipment—including all types of models such as vapor, immersion, and spray—most notable development has been in the design of conveyor equipment for the full automatic handling of work through the degreasing cycle.

In one case a gravity-roll conveyor applied to a three-dip immersion degreaser is so arranged that it will handle either straight baskets of work or rotating cylindrical baskets of work for complete drainage. The conveyor mechanism is designed to automatically transport the work from the gravity loading conveyor onto the cross-rod conveyor equipped with special fixtures which transport the work loads through the degreaser, and then automatically unloading onto another gravity roller conveyor.

There are also special immersion-type degreasers equipped to handle rotating baskets that give complete drainage to cup-shaped work, thus preventing solvent carry-out and wastage.

One very interesting installation comprises a vapor-spray-vapor degreaser equipped with a three-compartment mesh belt for automatically conveying work through the degreasing cycle and onto three separate belt conveyor lines. A cascade step in the conveyor flight inside the degreaser effects drainage of the work just prior to leaving the vapor zone.

Small, compact, single-stage metal parts washers recently developed will have important post-war uses in many small screw machine shops and small parts manufacturing plants for batch cleaning operations. With this type of unit, tote pans of work are dumped into the chute at the front of the machine. The work is then carried by spiral rotation to the rear of the machine where it is deluged with alkali or emulsion-type cleaner, whichever is required for the cleaning operation. This equipment is arranged for automatic timing of the cleaning cycle and unloading of the cleaned parts into boxes or clean tote pans.

To augment cleaning with chlorinated degreasing solvents, numerous improved materials for alkali and emulsion cleaning have been brought into the field. These new materials (e.g. new carbon-remover compounds) have an important place due to the complex cleaning problems encountered in war production, many of which will continue after the war. Considerable research has been devoted to producing non-flammable emulsions and solutions for the removal of Magnaflux, wetting out of very tenacious drawing and buffing compounds prior to electrolytic cleaning, and subsequent operations such as rust protection.

The exceptionally low concentration with which these products can be used indicates their high wetting and penetrating properties, as well as their emulsifying ability for mineral oils. In addition, they provide temporary rustproofing of ferrous metals during process of manufacture and a good base for subsequent painting.

Alkaline Cleaning

by J. J. DUFFY, Jr., Pennsylvania Salt Mfg. Co., Philadelphia

Metal cleaning has been an important part of the daily process operations of virtually all metal working industries—in particular, those concerned with finishing. During wartime the emphasis on finishes has been primarily that of corrosion and wear resistance rather than appearance. In every case, however, the finish created a need for a suitably clean surface which will yield smooth, adherent, fine quality coatings.

Alkaline cleaning—both straight immersion and electrolytic—has met these needs and served well. The chemical cleaning processes were found, at the outset of war production planning, to be well suited to high production schedules. Chosen according to the recommendation of the cleaner manufacturer or in compliance with government or private industrial specifications for the particular cleaning requirements of a variety of metals, alkaline cleaners have found innumerable applications, such as: (1) Preparing steel armament and ammunition components for painting; (2) removing drawing compounds and cutting oils from brass and steel shell cases between the various machining operations; and (3) cleaning a variety of aluminum alloys prior to anodizing and spotwelding, etc., etc.

The relocation of industry has turned attention to available water supplies and has forced improvements in alkaline cleaners which are less vulnerable to difficult water conditions; the continued shortage of suitable wetting agents has brought about improvements not only by the use of untried chemicals, but cleaning cycles as well.

No doubt, the belief still exists in some quarters that any alkaline cleaner, given time, will remove all soils from a metal surface. This belief has not only been proven false during wartime changes of lubricants, but, in essence, neglects the very important requirement of metal protection while the part is being cleaned.

Modern alkaline cleaning is no longer a simple matter of saponification and emulsification of the soil materials. Selection of proper detergent ingredients must be made with due regard for the nature and quantity of soil, the alloy or metal being cleaned, equipment available, time allotted and the subsequent treatment. Ingredients compatible with, and which overcome difficulties resulting from hard water, are of the utmost importance. The resultant detergent must have good penetrating, saponifying and/or emulsifying, dispersing and deflocculating characteristics.

Particular attention has been given to the unusual properties of certain ionizing organic compounds which cause otherwise insoluble materials to dissolve. This phenomenon has led to incorporation of so-called "solubilizing" agents in detergent formulae in addition to wetting, dispersing and deflocculating ingredients. Selection of the proper detergent to remove the newer drawing, cutting and stamping lubricants can now be made with due consideration to the factors of equipment and subsequent treatment, on a much sounder basis.

Billets to be made into seamless steel tubing are shown here being quickly "centered" by an oxy-acetylene blowpipe

Multi-machining operations on aircraft supercharger parts

Rubber-pad type hydraulic press for shallow forming

Shot Peening by L. L. ANDRUS, American Foundry Equipment Co., Mishawaka, Ind.

Shot peening is a method of increasing the fatigue life of a machine part by prestressing in compression those surfaces which in regular operation are subjected to repeated cycles of tensile stress in bending or torsion. The lower net stress in the surface layer of metal delays the start of fatigue failures, and an improvement of 300% to 900% in the fatigue life of various machine parts has been repeatedly demonstrated.

The prestressing process is accomplished by subjecting the surfaces in question to a rain of metallic shot in peening machines designed for the purpose and employing either a wheel or compressed air to hurl the shot. Shot sizes commonly used may vary from 0.030 in. to 0.100 in. in diameter. Steel shot is urgently needed for the process, but pending its development, a special separating device is used on peening equipment to discard fractured particles of the ordinary commercial iron shot now employed for the purpose.

Peening had been in use for a number of years in the processing of leaf and coil springs for the automobile industry, but not always with consistent results. Process control was sorely needed and a way had to be found to specify the intensity of the "blast" of shot used in the peening process, and subsequently checking this intensity in commercial production. This need was met through the invention and development of a gage for this purpose by J. O. Almen of General Motors Research.

The progress of the war did not permit time for design changes to eliminate fatigue failures in engines and other ordnance materiel. Shot peening was rapidly applied to eliminate early fatigue failure in a wide variety of parts. All tractor tread pins produced in 1944 for one model of tank were shot peened. Transmission gears and torque rods on certain military vehicles have been processed in this way for a similar period of time.

Valve springs for certain aircraft engines are now shot peened, and equipment has been provided for peening other engine parts, with production now in the initial stages. This is also true of some aircraft gears.

The recoil springs of certain guns, and other parts of smaller weapons, are similarly processed. The increase in the use of this method will continue in connection with ordnance materiel, but its function will be limited to increasing the fatigue life of the weak points in existing designs.

The shot peening process will not reach its full development until the post war period, when the original design of new engines of all types and equipment for ground and air transport is actually influenced by the benefits of the process. To quote an example, a given load can be transmitted through smaller gears than previously used if the gears are shot peened. A vast amount of costly hand polishing of engine parts will be eliminated because shot peening the same surfaces will give a longer fatigue life at far less cost.

There will be many cases where the use of expensive alloy steels will no longer be necessary due to the improved fatigue life of parts made from ordinary steels and shot peened. Results of the process are so phenomenal its use is certain to spread.

Barrel Finishing by R. W. MITCHELL, Magnus Chemical Co., Garwood, N. J.

Aside from the continued development of better lubricants for use in barrel finishing, which has been a steady factor in this field for many years, perhaps the most interesting development of the past year has been the considerable progress achieved in the use of the burnishing barrel for the bulk de-burring of metal parts which would otherwise require a great deal of hand finishing for the removal of burrs.

The results that have been obtained by careful selection of suitable lubricants which prevent metal to metal contact yet allow a cutting action by the abrasives of the barrel load on projecting burrs, have led to surprisingly large savings. No set formula has been developed for the solution of these deburring problems. Experimentation with various abrasives and lubricants seems to be the only way to determine whether or not a job can be done in a barrel. Sand, alundum, emery or carborundum have all proved satisfactory as abrasives for different metal objects.

Some satisfactory results have been obtained on a sand-water mix, but action is slow and some danger of pitting exists. Mineral oils as lubricants work out fairly well—but perhaps the most promising development is the use of solvent soaps which seem to give superior protection against undesirable dimensional changes, while speeding up the deburring action. These soaps also have the advantage of insuring faster and better removal of lubricant and metal particles after deburring without special washing procedures. These solvent soaps have been successful when used with granite chips on both steel and aluminum parts.

It should be noted that certain parts cannot be handled in a barrel, either because of their size or shape or because the kind of burrs that have to be removed are too heavy or too inaccessible. However, when the tremendous difference in production between deburring by hand filing and barrel deburring is considered—(a ratio of as much as a hundred to one in many cases)—it is easy to understand why so much time and testing have gone into the possibilities of the barrel in the past year—and why such excellent progress has been made.

Some highly interesting and efficient barrel-finishing machines and processes have found wider application in recent months. One—a net process—combines three separate operations (grinding or deburring, honing and "coloring") and is specially useful for large or irregularly shaped parts or for the production of an exceptionally smooth bright finish.

Advances have also been made in size of equipment, in control and automatic operation features and in equipment for separating parts from the compounds and for charging and unloading.

Anodizing by M. R. MURLLESS, Monroe Calculating Machine Co., Orange, N. J.

The greatly increased use of aluminum and its alloys in every type of aircraft, radio and photographic equipment and other instruments of war has accelerated the interest in processing these materials and especially in anodizing them in a large number of concerns that heretofore had never used them.

In practice, the work is made the anode in an electrolytic bath. Three different electrolytic baths are in commercial use today, chromic acid, sulfuric acid, and oxalic acid. The former two are the most important and widely used; the latter one finds a limited use in special applications such as in the deposition of other metallic coatings on aluminum.

The solution most frequently used today in commercial practice is the chromic acid bath. It cannot, however, be used on aluminum alloys containing more than 5% Cu. It is the easiest to control and requires the simplest installation of equipment.

The tank is steel and is made the cathodic side of the circuit. Important accessories like agitating equipment, exhaust systems, steam coils and automatic temperature controls, and D. C. power supply permitting regulation up to 40 volts capacity, have all been improved in engineering efficiency or versatility in recent months.

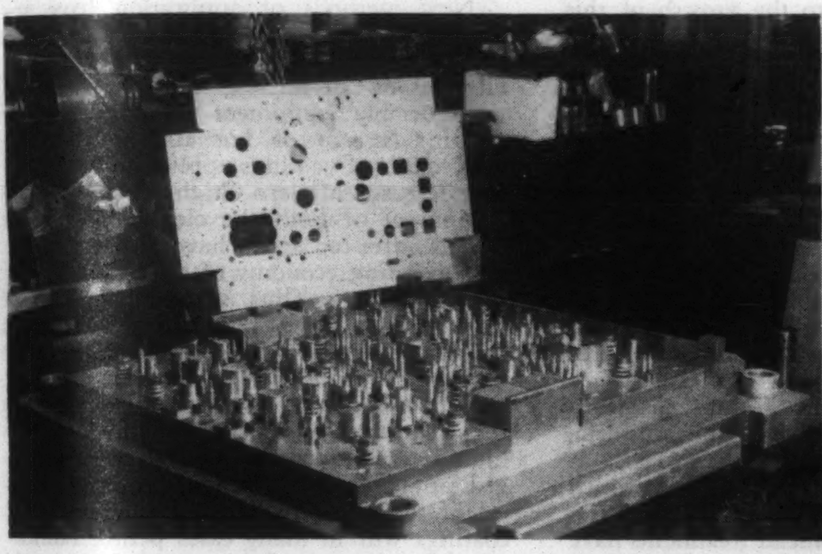
Laboratory control of the bath concentrations is increasingly employed to yield the most consistent and uniform type of anodic treatment. The chromic acid is held between six and nine percent by weight, with the alumina content held to a maximum of four percent by weight, but generally operating around one to two percent.

Electrometric determinations of pH with a glass electrode are made quickly and many operators are finding them an easy method of maintaining control of the solution. Present operating conditions for wrought material are 40 to 45 volts at 100 F for 1 hr. and for cast material from 30 to 35 volts at 80 F for 1 hr.

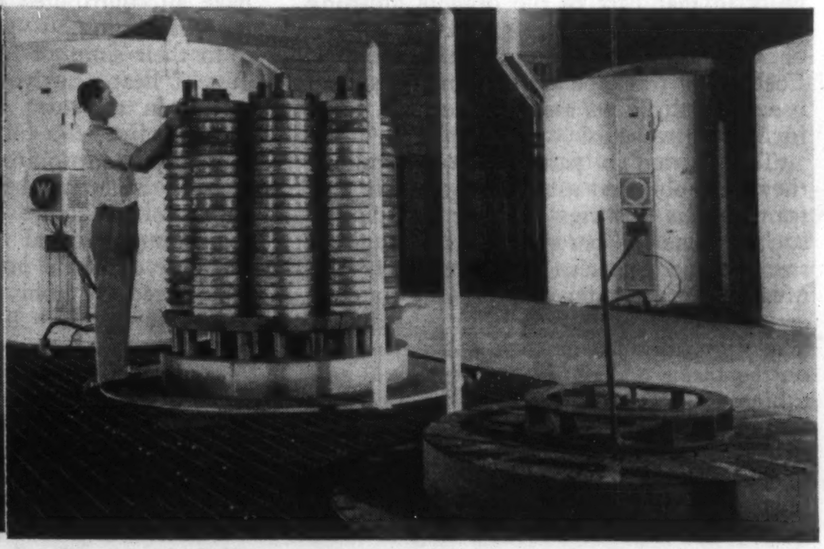
Racking of the work has assumed outstanding importance. Internal contacts where possible are now considered essential, with racks and contact points made of aluminum or an aluminum alloy for all work that is to be completely submerged in the electrolyte. Sealing is generally done either in boiling water or a boiling 5% potassium dichromate solution for thirty minutes and followed by a cold and hot water rinse.

The oxide film thickness generally produced is between 0.000001 and 0.00008 in. with about 0.00002 in. the average thickness in a normal treatment of die casting, permanent mold casting, and wrought material. Sand castings may run slightly higher in film thickness.

Chromic acid anodic films are not as hard as the film produced in a sulfuric acid bath, though they are more resistant to corrosion. It is reported that in spite of this softer chromic acid film the abrasive resistance of aluminum treated surfaces, face to face, is better than a sulfuric acid film. Sulfuric acid treatment yields the most suitable film for dyeing with organic dyes and mineral pigments because of their greater thickness and porosity.



Part of a progressive die for blanking and piercing



Bell type nitriding furnaces for aircraft parts

Metallizing by EDWIN LAIRD CADY, Contributing Editor, METALS AND ALLOYS

Without losing any of its importance as an emergency method for repairing worn parts and building up flawed or under-sized parts, metallizing is moving "out of the blacksmith shop" and is rapidly becoming a production line technique.

One example of this is the tumbling barrel metallizing of small parts, in which the parts are placed in tumbling barrels or baskets and then cascaded in the path of a metallizing spray. In this way speed nuts are zinc-coated to rust-proof them, metallizing taking one hour for the same number of parts that other processes would require twenty hours to finish. Other threaded fasteners are barrel metallized to give their threads more friction and therefore more holding power. Small parts made of glass, ceramics, plastics, woods and various metals are barrel metallized to give them electrical conducting coatings.

Metallizing is combined with welding equipment to prepare hardened steel and other "difficult" surfaces for building up. Steel or aluminum welding rod is fused to the surface to be metallized; the rough surface thus obtained is ideal for the adherence of the hot sprayed metal. This technique, greatly advanced within the last two years, not only extends the field of metallizing as a repair method, but also permits short raised sections (for bearing seats, force fit areas, gear or pulley seats, etc.) to be built up as production operations on straight shafts rather than requiring those shafts to be machined down over long sections so that short sections may be left standing.

Preparing studs and other parts for flash welding is a new metallizing production operation. The stud areas where the welds are to be made are metallized with about 0.005 in. thickness of aluminum which acts as a deoxidizer or flux. More than 2,000,000 of these studs have been used on the Pacific coast alone.

Hot spraying of two metals simultaneously so that both impact the same area, is a production line operation which is gaining in importance. Copper and lead, for example, are sprayed from two different metallizing guns in such manner that the two metals are mingled on a bearing surface. The bearing then has the strength and heat conductivity of the copper with the low coefficient of friction of the lead.

Electrical degumming of plastics as well as of woods, leathers, papers, etc., has permitted hot sprayed metals actually to bond themselves with these materials. The result is an entire new production field which may give birth to a new post-war industry.

Metallizing equipment makers are producing new alloys suitable for their processes. One of the latest is an aluminum that machines with long chips and to a high finish. Metallizing companies are selling carloads of wire where prewar they did not sell tons—a clear indication of the extent to which metallizing is becoming a production process in contrast with its early use chiefly for maintenance.

Electroplating by VERNON A. LAMB, National Bureau of Standards, Washington

The requirements of war production and the scarcity of certain metals have dictated changes in the kinds of articles plated, in the amounts of the various plating metals consumed, and in the purposes for which plated coatings are applied. However, the volume of electroplating being done at the present time is nearly, if not fully, equal to that done prior to the war.

The metals now most used for plated coatings are cadmium, zinc, lead, and tin, for corrosion protection; and chromium and silver (with lead and indium) for resistance to wear. Silver and gold are plated on radio parts for good high-frequency conduction, rhodium where high reflectivity and tarnish resistance are required.

The earlier limited supply of zinc has resulted in studies of lead coatings and in their increased use for corrosion protection. Both hot-dipped and electroplated coatings are applied. Lead does not entirely protect steel exposed through pores or scratches, but if the coatings are reasonably heavy, flaws are apparently sealed by corrosion products. A sub-committee of B-8, A.S.T.M., in cooperation with Battelle Institute, is conducting exposure tests of lead-plated steel. It appears that for some applications and in certain environments lead is superior to zinc and it should have continued postwar applications.

The scarcity of tin has led to the installation of numerous lines for tin plating strip steel for food cans. The thinner plates that can be applied by this method effect extensive savings in tin. Indications at present are that use will be made of these thin plates after the war for packing many non-processed foods, but that for many processed foods thicker coatings, probably hot-dipped, will be required.

The use of thick chromium deposits for salvage of worn parts, and for increasing the life of cutting tools, gages, dies, etc., has increased. Porous chromium, which is ordinary "hard" chromium etched to produce an oil-retaining surface, is being increasingly used. The porous chromium plating of aircraft engine cylinders, particularly to salvage used cylinders, and of Diesel engine cylinders for marine and tractor service, is in large production. Cylinders with this finish have several times the life of unplated cylinders.

Electrodeposited silver, followed by lead and indium, has been found excellent for aircraft bearings, or other bearings subjected to high speeds and heavy loads. The combination has "oiliness," resistance to corrosion by acids present in lubricating oil, and a high resistance to fatigue failure.

Electropolishing, and plating on plastics may be mentioned as two other developments which are being increasingly used.

Many applications of electroplating of a confidential nature, some of which will undoubtedly find continued use after the war, cannot be discussed at the present time.

Organic Finishing by R. G. FULTON, Bakelite Corporation, Bloomfield, N. J.

Unusual progress has been made in recent years in that part of the organic finishing field represented by resin baking finishes or thermosetting phenolic resin coatings. Coatings of this type are now in widespread use and indications are that they will serve in many new fields.

This is due in part to the recognition they have obtained as a result of their performance as coatings for war equipment, such as interior parts of aircraft engines, steel cartridge cases, food containers for Medical Corps, water and gasoline containers, machine parts and military hardware. The successful use of such baked coatings on the inside and outside of steel pipes and tubing for heat exchangers and low pressure boilers has also opened up extensive fields in corrosion resistant coatings.

Coupled with their newly acquired prominence are the factors of their improved quality and a better understanding of their characteristics. Furthermore, advances in other fields have contributed much to their usefulness. New and improved metal treatments, methods of application, methods of baking and progress in related coating fields have all contributed to the growth of this type of coating.

In their simplest form, such coatings are merely heat reactive phenolic resins dissolved in solvent. After the coating has been applied, the film is converted to infusibility and insolubility by the application of heat. Such baked films have a very high degree of resistance to solvents, corrosive conditions, chemical reagents and abrasion. To these desirable properties can be added their freedom from softening at elevated temperatures, their hardness, and the fact that very thin films afford a high degree of resistance.

As a result of study of their characteristics, it is now possible to apply uniform, defect-free films having film thicknesses as low as 0.1 mil, and under conditions which were formerly impractical.

New and improved metal treatments have aided the growth of this type of coating. Metals which were formerly difficult to coat properly can now be readily coated by employing a metal treatment prior to coating.

New methods of application have appeared. These include automatic spraying equipment, electrostatic field spraying and electrostatic de-tearing, also the use of transportable equipment to provide a circulating stream of hot air for the heat conversion of coatings applied to large surface areas. Modern high speed drying equipment of both the electrical and gas-heated infra-red types have also improved the operating economy of the baking phase of the process. Thus, such smooth protective coatings are applied, for example, to railway tank cars, huge industrial metal tanks and even to the holds of ships.

Where application on thin metal sheets is required, these resins are modified to give highly flexible coatings which possess the greater share of the resistant properties typical of resin baking finishes. Such modified coatings will in many cases permit fabrication of metal parts from coated sheet metal. An example of this is the production of closures and food containers from coated tin plate.

Metal Coloring by WALTER R. MEYER, Enthone Co., New Haven, Conn.

The metal color used predominantly at present is black but there is wide postwar interest in colors. Aluminum is best blackened by sulphuric anodizing and dyeing although chromic acid anodized coatings are blackened to some extent. Zinc is blackened by "black nickel" solutions, buffered molybdate and modified chromate solutions either by chemical or electrochemical means. Cadmium is more difficult to blacken than zinc but is being blackened by molybdate and chromate solutions.

Nickel is being blackened by the use of strong, aqueous oxidizing solutions and stainless steels by using fused sodium dichromate. Steel is being blackened by the well-known caustic oxidizing solutions and fused oxidizing salts, but to get increased corrosion protection there is more use of zinc or copper plating and blackening of the zinc or copper.

There has been much demand for blackening of copper and copper alloys with methods involving direct chemical oxidation to black cupric oxide being used most generally. These coatings protect copper from 20 to 100 hrs. in salt spray and are absorptive of oils, waxes and paints to give high protection to the base copper. Black nickel plating is not recommended directly on copper.

Blackening of brass in ammoniacal copper solutions works well for high brasses and is an easy method to use. Because of this ease, it will be practiced considerably for post-war blackening although the coatings are not as corrosion resistant as the cupric oxide coatings formed by chemical oxidation.

Silver is being blackened by sulphide, telluride or platinum solutions.

Coloring of war goods is done largely by means of organic finishes, but there is wide post-war interest in inorganic colors. For overall cheapness, sulphide finishes will be used extensively. However, where more durability of color is desired, other means will be used. New methods are available for coloring zinc, and a very fine method is available for coloring copper, its alloys and particularly brass. One method involves electrochemical deposition of copper oxide with the ability to form many colors according to the conditions and time of treatment.

One coloring method, which will find wide use because of its ease of operation and wide range of colors formed, is based on direct chemical oxidation of copper or brass to many shades of colors—gold, green, blue, brown, statuary bronze and Old English. The finishes are stable chemically and do not "crystal spot" in the manner of sulphide finishes. Probably post-war uses include coloring of hardware, buckets, buttons, urns, tacks, pins, toilet accessories, screen, nameplates, lamps and ash trays.

Buffing

by R. P. CRANE, The Lea Mfg. Co., Waterbury, Conn.

Buffing and polishing, or the removal of surface imperfections by abrasion, is a rather unique branch of industrial fabrication. Unlike some other more flexible types of processes, revolutionary developments or improvements are practically unheard of.

There has been considerable evolution, however, not so much in the fundamental process as such but in the technique of application. Many war project engineers have adapted some variation of the polishing and buffing operation to overcome production bottle-necks.

Probably one of the outstanding developments in this connection was the solving of the burring problem. Precision was the keynote and blueprints by the thousands carried specifications such as "All parts must be free of burrs. All sharp edges broken."

The logical approach, to many production men unfamiliar with the buffing and polishing field, was to use a file. This dependency on files to do the entire burring operation instead of confining them to their obvious place in the sequence resulted in many distressing production tie-ups. Consequently, men who otherwise would have had very little contact with buffing and polishing became enthusiastic proponents of the wheel procedure for burring. Some engineers were skeptical that tolerance could be maintained in this manner but the results proved highly satisfactory. Since then practically every precision or friction-bearing part used in the war effort has had a buffing or polishing variation somewhere in its development.

As a result of this emphasis new developments were: Improvements in automatic buffing and polishing machines both straight line and radial; abrasive impregnated fiber wheels; vari-shaped felt, rubber and steel mounted points; especially designed wire wheels; treated Tampico wheels; string and cord brushes; paper wheels; better abrasives; cements and wheel glues along with many new grades of greaseless burring compositions and abrasive compounds.

During a period of national emergency there is always a tremendous improvement in technological progress along many lines and buffing and polishing was no exception. The commercial application of electro-polishing which is the only revolutionary development ever conceived in this field is an example. This consists of the reduction of surface imperfections in the presence of an electrolyte. Considerable progress has been made with this technique and today the process ranks as an outstanding contribution to the buffing and polishing field where high production rates prevail and where economy has always been important.

Post-war application of these new developments in buffing and polishing is assured by the great increase in production efficiency directly traceable to them.

Blast Cleaning

by P. J. POTTER, Pangborn Corp., Hagerstown, Md.

During the first quarter of 1944, orders for blast equipment did not keep pace with expanded production facilities, and the manufacturers worked into their backlog. It appeared as though wartime demand was satisfied; therefore, some of the companies pointed their sales efforts to peacetime products. However, before the end of the second quarter, there was again an urgent demand for additional ordnance equipment, and this surge of orders has kept the manufacturers busy to date. The recent orders are all for larger sizes, and specify increased daily output, reflecting the quickened tempo of war.

The worldwide activities of our Navy make necessary fully equipped repair bases in many out-of-the-way parts of the world, requiring blast cleaning equipment for ship hulls, airplane engine cylinders, spark plugs, powder cans and many others. All these machines must be designed so that they can be erected with a minimum of skilled mechanics, and each machine's operation studied, so the supply of parts and accessories which must be shipped with machine will be sufficient for several years. For machines that are to be operated on a tropical island in the Pacific, the protection of bearings, motors, gearing, brightwork and steel plates against moisture and rust is a problem.

The trend of 1944 for what peacetime blast cleaning products have been produced is the continuation of demand for completely mechanized installations. A monorail type conveyor carries the casting through blast room. Within the room, each casting is rotated in front of several blast cleaning machines located so that the abrasive strikes all surfaces of each casting. The operation is continuous, the castings being hung on or taken off conveyor outside of blast room.

This type of cleaning installation was introduced among the motor manufacturers several years before the war, for blast cleaning motor blocks, transmission cases and other cast parts. These mechanized plants were successful in reducing costs, improving the appearance and machinability of castings, and providing better working conditions for the operators.

Their success attracted attention of manufacturers of other cast parts such as bath tubs and sanitary ware, heaters and radiation, tractors, etc. Similar installations with work hangers so arranged that a variety of shapes and sizes can be suspended therefrom, are now in use in jobbing steel foundries.

The unmistakable trend in blast cleaning equipment is: (1) Power handling of the castings, (2) fully mechanized blast cleaning equipment, (3) complete dust control.

Rustproofing and Packaging

by HAROLD A. KNIGHT, News Editor, Metals and Alloys

"Exports" now generally consist of sending munitions to our overseas service units, ranging in size from needles for bearings to railroad locomotives. Before the war American exporters were notoriously sloppy, steel items arriving at destination with kegs of nails burst open, steel beams bent, other steel items brownish red from corrosion and with many units missing.

The past few years have shown that the two chief hazards in overseas shipment are mechanical and corrosive, with the latter more difficult to combat. Mechanical damage is fairly easy to guard against with wooden boxes, wrapping paper and dunnage. Corrosive hazards are salt water spray and mist and rapid changes in temperature, with the added hazards of fungus growth, abrasive action of coral dust, sulphides from swamp and jungles and various mildews and bacteria ad infinitum.

Popular for the thousands of small parts have been the "Stripcoat" type of Dow and "Plastic Peel" of Hercules Powder Co. After the parts have been cleaned in the orthodox way, they are dipped into an ethylcellulose mixture held around 375 F, removed immediately, drained, and presto, the coating has hardened into an effective air and moisture seal. At destination, the peel is slitted with a knife and easily removed and the material perhaps remelted.

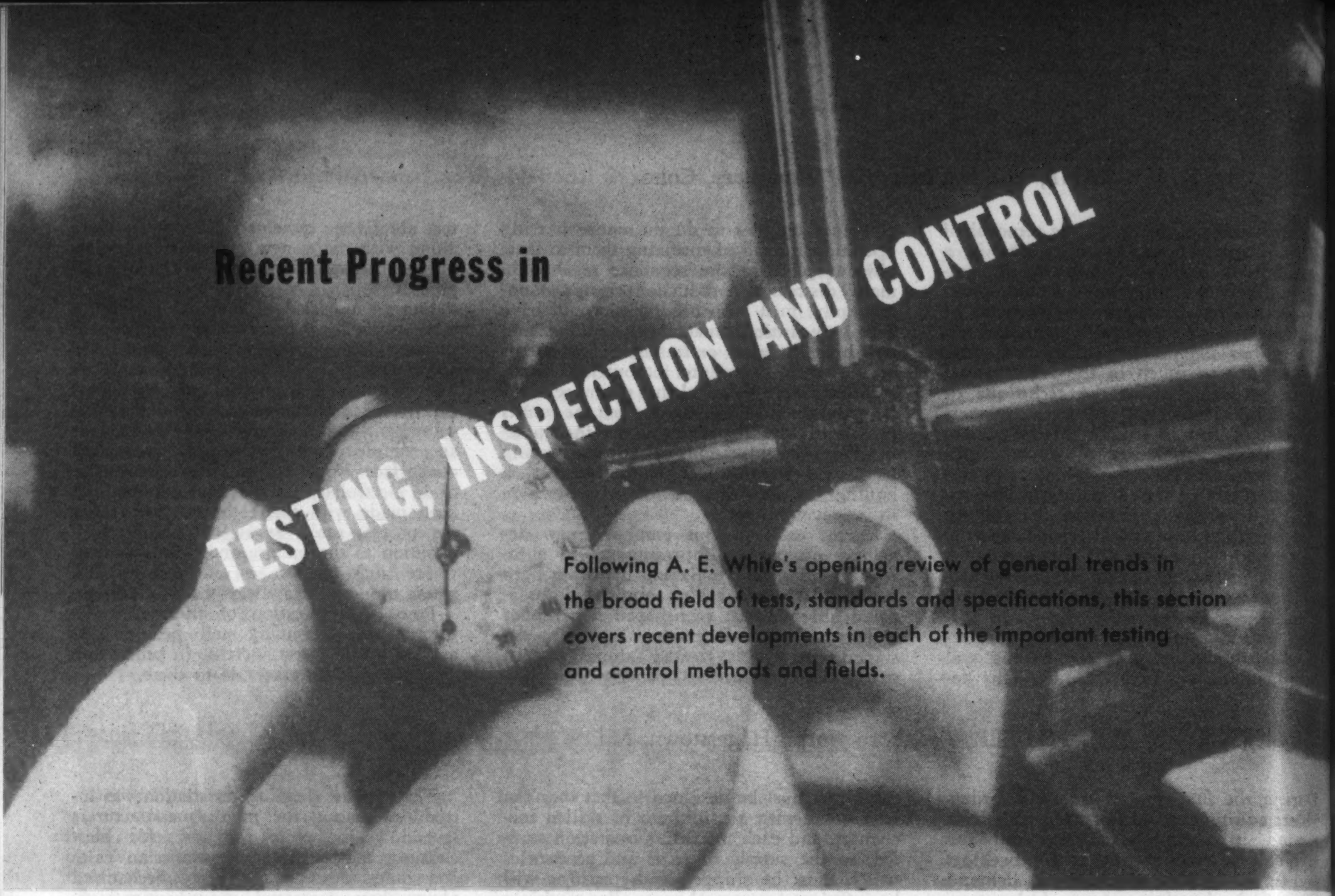
For larger items, particularly with irregular shape, loose fitting film bags are now used, containing a silica gel to absorb moisture, and perhaps sealed at the neck with a malleable lead ring that is squeezed shut. At first "windows" were inserted into outer wrappers to observe the silica gel for inspection as to need for renewal. However, so much "know how" has been acquired that the first application of the gel is now accepted as sufficient.

Perhaps the most spectacular method is the spraying of Vinylite resins over large masses, such as airplanes. Shot from a spray gun, they harden at under 30 min. into a protective coating. At debarkation ports the plastic coating is stripped by three or four men in an hour. The former petroleum coatings would harden, perhaps develop shrinkage cracks and take 250 man-hours and much solvent to remove.

Three main divisions of packaging are: Unsealed wrappings; sealed wrappings (where the wrapped package is dipped in melted wax, or equivalent) and wrappings containing a dessicant, dehydrant or absorbent. Typical items wrapped in the first are semi-finished castings; of the second, pistons and rings; of the third, assemblies of mixed metallic and non-metallic materials.

Special wrapping papers have been developed that are greaseproof, acid-free, noncorrosive, moldable and sealable.

The past few months have produced three outstanding developments: (1) Asphalt impregnated fiberboard 1/8 to 1/4 in. thick, for lining large nailed wood boxes, sealed at the joints with asphalt mastic type sealers. It strengthens the wood boxes, gives added cushioning and resists water. (2) Aluminum foil as a wrapper for highly finished and critical items, such as surgical instruments, first coated with light oil. All is then placed in a sealed envelope. (3) So-called "Desiccite" substitutes for silica gel because of shortage of the latter. One uses it, 1½ times the weight of gel, but because of greater density, volume is the same.



Recent Progress in TESTING, INSPECTION AND CONTROL

Following A. E. White's opening review of general trends in the broad field of tests, standards and specifications, this section covers recent developments in each of the important testing and control methods and fields.

Tests, Standards and Specifications

by A. E. WHITE, University of Michigan, Ann Arbor, Mich.

Excellent progress has been made during the past year in the unification of tests, standards, and specifications. A great deal of this progress has been the result of the cooperative efforts between the War Production Board and Mr. C. L. Warwick, Secretary of the American Society for Testing Materials. It has resulted in a wider and more extended use of the Standards of the American Society for Testing Materials, modified and changed in some instances by emergency alternate provisions emanating from the War Production Board. Also, numerous specifications have been issued by this Society, known as emergency specifications, which have been prepared as the result of the close cooperation with the War Production Board. These activities have resulted, in many instances, in unification of specifications for the same material or substantially the same material for many different purchasing agencies.

In specification writing, two basic trends are distinctly in evidence. One is the development of service tests for determining the suitability of a given mechanism or part of a mechanism. Although it is rarely, to date, that such a test becomes part of a specification, there is evidence that there is an increasing trend in this direction.

This development is closely related to the growing interest in classifying and purchasing materials—especially steels—on the basis of properties or performance rather than according to composition-specifications. The property most frequently suggested as the primary basis for acceptance of engineering steels is hardenability. Suitable tests have been developed for measuring this property, but there is still not complete agreement as to whether hardenability should be the general criterion for appraising the ultimate performance of a steel.

Another rapidly developing trend is in the establishing of tests and specifications for consumer household goods. This development has been retarded because there has been no one single interest in a position to underwrite the cost of preparing specifications for household consumer goods. To be sure, some of the larger merchandisers have done work in this field in order to protect their interests in the purchase of materials and supplies from wholesalers. Yet, the householder has had little protection in this field other than that available through the reputation of the company from whom he buys his products or the brand purchased. That he has, in the main, been protected speaks well for the honesty and integrity of the manufacturers.

One of the fields in which a simplification for testing is badly needed is that for the determination of the properties of metals at elevated temperatures. Creep tests take at least 1000 hours and stress rupture tests run from 10 to 1000 or more hours. Even when these tests are made, it is necessary to run service tests. Mention would normally not be made of this need, except for the fact that at this time much attention is devoted to metals for elevated temperature service as they are used in turbo-superchargers, in rockets, in jet-propelled planes, and in gas-driven turbo units as they may be applied to steamships and locomotives.

The tools of the testing engineer have shown some remarkable progress in recent years. The electron microscope, hardness testers for microscopic areas, X-ray diffraction units, more fool-proof flaw-detection equipment, spectrographs that speed composition-control, more powerful radiographic machines, measuring devices that reduce the human error to its absolute minimum, quality control by statistical methods—these and a host of others have contributed simultaneously to research and development as well as to acceptance and process-control testing.

Wholly new types of testing have been opened wide in recent years by demands of designers for more strictly-design information. Notable in this respect are the growing use of stress analyses and dynamic balancing tests as guides to best design.

Sound design and efficient production depend directly on intelligently planned, correctly performed tests. It augurs well for our future that a greater amount of useful testing is being done now than at any time in our industrial history.

Gaging and Dimensional Inspection

by GEORGE M. ENOS, Lt. Col., Ordnance Department, Cincinnati Ordnance District

In the field of dimensional process inspection the major trend observed during 1944 was the increasing use of indicating instruments in place of fixed limit gages. Magnifications of 1,000 or 2,000 to 1 projected on a comparator scale eliminates much of the human element which enters into the use of fixed gages, results in economy of gaging time, and provides a better control medium through exact measurement of the dimension. In the field of acceptance inspection, statistical control employing the use of fixed gages continues to predominate.

Increasing use of air gages has led to the development of the air snap gage which differs from the conventional snap gage in that variation between the tolerance limits is indicated. Air plug gages continue in popularity with many ingenious variations being developed in which several dimensions can be checked with one use of the instrument such as taper, variation in steps and diameter, and if desired, both internal and external dimensions can be measured with the same application of the gage.

Machines doing multiple gaging are very popular. The saving of man hours by the use of such type gages is enormous and many new applications have been found during the year. An improvement in the electric features of one of the multiple checking instruments is the use of an electronic circuit which eliminates many moving parts such as relays. There are minor improvements in electric gages incorporated in the new models of the various manufacturers.

An interesting development is a new electronic piston ring inspector. This instrument provides for a light beam which scans the width of gap and also scans the ring for out-of-roundness in comparison with the master ring. These deviations are noted with an electronic circuit and lights indicate acceptance or rejection.

The checking of threads is made easier and more positive by the adaptation of a dial indicator or high magnification comparator to one "no-go" roll of a thread roll snap gage giving an actual reading on pitch diameter. The "go" rolls are of conventional design.

The use of chromium plating on gages is not new, either for reclamation or for increasing life. However, improvements in technique and in the variety of applications continues. Claims of increased wear life on precision chrome plated thread gages varies from 100 to 1,000 per cent increase.

In general, glass gages have not proven too satisfactory due to shorter wear life, original cost, fragility, and unfavorable coefficient of expansion.

The cooperation of Sheffield Gage Corp. and Captain Walter S. Veon in preparing this review is appreciated. The opinions expressed in the article are those of the author and are not necessarily those of the War Department.

Mechanical Testing

by H. S. RAWDON, National Bureau of Standards, Washington

Advances in this field during the year have consisted largely in refinements in methods and test specimens.

Hardness.—Under the auspices of a Joint Committee (Society of Automotive Engineers, American Society for Testing Materials and American Society for Metals), commendable progress has been made on hardness conversions with especial consideration to the basic factors which should form the basis of such conversions. Methods for hardness determinations of very small areas, coatings and brittle materials have continued to receive study.

Comparative data obtained at the National Bureau of Standards with the two leading types of microhardness indenters have demonstrated the reliability of both types of indenters for loads not exceeding 1000 g. Contrary to previous belief, it appears that slight elastic recovery occurs in the long diagonal of the Knoop microhardness indentation and suitable correction is necessary for very precise measurements.

Tension.—Noteworthy success has been attained (McGregor, Massachusetts Institute of Technology) in the correlation of the results of notched-bar impact tests and those of static tension, if the *true* stress values are used. Creep and stress-rupture tests, with emphasis on the second, continue to receive attention in the study of materials for special airplane equipment such as superchargers and jet propulsion.

In the forming of sheet metal parts, as for aircraft, "spring back" in the formed material is an important factor. Evaluation of a material in this behavior in terms of the basic characteristics of the sheet is now possible. Investigations on stress-corrosion and of effects of cold-treatment have necessitated much testing but have not led to any basic changes in test procedures.

Fatigue.—The Fatigue Research Committee (American Society for Testing Materials) has continued to contribute important information on this test, particularly on effects of test-specimen variations. A high degree of surface polish appears not so essential as was formerly supposed. In particular electropolishing of fatigue specimens has not proved very encouraging. The beneficial effect of a compressively stressed surface layer as a means for increasing fatigue life of a metal part has been established.

Shot-peening of structural metal parts as a means for obtaining this condition has leaped into the spotlight. Some strengthening of the surface metal in the processing of fatigue specimens is to be expected and this factor should be considered in the evaluation of the material tested.

The trend continues to be strong in favor of the fatigue testing of full-size units. In the fatigue testing of airplane structural material (National Advisory Committee for Aeronautics), special consideration has been given to factors tending toward stress localization, notches, rivets, etc. A laboratory test method has been described for the early detection of a fatigue crack and its rate of propagation.

Hardness Testing

by HOWARD SCOTT & F. C. HULL, Westinghouse Research Laboratories, Pittsburgh, Pa.

The outstanding development in hardness testing has been in the field of hardness conversion relationships for metals softer than 250 Brinell. Robert H. Heyer, assisting the joint ASM-ASTM-SAE Committee on Hardness Conversions, has presented a paper to the ASTM which will clarify a confused situation. Brinell, Rockwell and Vickers impressions may be classed into three groups based upon their vertical contour—(1) Ridging, (2) Flat, and (3) Sinking. Ridging impressions are characteristic of cold worked materials and metals of low work hardening capacity. Flat impressions represent an intermediate degree of work hardenability, and sinking impressions are characteristic of fully annealed materials.

Accuracy of conversion from one hardness scale to another is possible only if a chart is used which was determined for the same type of impression as is made in the material tested. The range of impression shapes from ridging to sinking represents a continuous series of work hardenabilities. Various methods for evaluating work hardening capacity are under study.

Much experimental work remains to be done, but the present indications are that accurate hardness conversion relationships can be made available for all classes of metals and alloys in all tempers and heat treatments.

For microhardness testing, the Tukon Tester used to measure Knoop Hardness is finding increased application in research work and to some extent in industry. The design of the tester has been improved so as to reduce certain errors that became noticeable at loads below 200 grams. An inertial load caused by lifting the beam and load from its rest was eliminated by a solenoid device designed by D. R. Tate which prevents the application of the full load to the indenter until the lifting mechanism has ceased to operate. Rocking of the indenter was reduced to a minimum by a spring attached to a torque arm on the elevating screw, which prevents play of the screw in its bearing during raising of the specimen.

The preparation of a metal surface for hardness testing is always an important consideration, but this is especially true of microhardness testing where the loads are light and the depths of penetration small. Annealed copper, for example, may show a 50% increase in Knoop Hardness Number (100 gram load) after polishing on metallographic polishing papers and final wheels, as compared to the true hardness of the material. In this field electrolytic polishing can be applied to advantage.

Magnetic Particle Inspection by W. E. THOMAS, Magnaflux Corpn., Chicago, Ill.

One of the best investigations conducted during the past year on magnetic particle inspection was performed by James W. Owens of Fairbanks, Morse & Co. presented at the October meeting of the American Welding Society.

Mr. Owens points out that the continuous dry powder method when used with direct current as the magnetizing means brings out indications of deepseated discontinuities, many of which are not defects but which may be openings between the plates being welded when 100% penetration is not required. Such indications are not only confusing to the inspector, who may not be sure that the indications are caused by actual weld defects, but may also hide true indications of such defects. Mr. Owens recommended, in such cases, the use of the dry method with alternating current as the magnetizing force as, due to the skin effect, the depth of penetration is not nearly as great as when direct current is used.

An appreciation of this basic fact has resulted in a much more positive interpretation of indications obtained on welds. To make possible a practical application of this inspection procedure, equipment has also been developed which delivers to the test piece either alternating current or direct current and the operator is thus able to obtain whatever degree of depth penetration is desired.

In a paper written by M. L. Mages of Magnaflux Corporation and presented before the Institute of Aeronautical Sciences the question of necessity of demagnetization during magnetic particle inspection and between magnetizing operations in different directions was discussed. Mr. Mages pointed out that demagnetizing between circular and longitudinal magnetizing operations is not only unnecessary but undesirable, and this corrects a practice of long standing to conduct such demagnetization.

Considerable additional work has been done to increase the sensitivity of the magnetic particle method in the location of deep-lying subsurface discontinuities, and progress has been made along this line. The use of magnetizing current methods which would cause the particles "to dance" on the surface of the test piece, and because of the additional mobility be attracted more readily to weak leakage fields, has been responsible for the improvement.

New methods of manfacture of indicating materials of the dry powder type has resulted in more tighly adherent colored coatings with the result that the powder may be used for a longer time, and also with much less inconvenience to the operator as much of the "dustiness" has been eliminated.

During the past year the A.S.T.M. has continued its work in the formulation of tentative specifications covering the magnetic particle inspection of heavy forgings and large castings.

Equipment design has tended in the direction of the more rapid handling of parts in order to reduce inspection costs. Conveyors and other automatic material handling devices have been employed, together with interesting automatic electric timing circuits, in order to magnetize parts, apply the inspection medium in either wet or dry powder form, carry parts past the inspector's station, and finally demagnetize without the necessity for individual handling.

Radiography by D. M. McCUTCHEON, Ford Motor Co., Dearborn, Mich.

Climaxing a year of important industrial development in radiography is the current X-ray film shortage. New applications of X-ray inspection to huge volume production items has made it difficult for the older, lower priority contracts to obtain adequate X-ray film deliveries.

Recent applications of electrical indicating methods for measuring X-ray intensities may offset new applications requiring X-ray film. Further application of electrical measuring systems are expected in those cases where radiography is used only as a check on metal thickress or other dimensional applications. One well publicized installation describes the use of an X-ray beam as a control on the thickness of steel sheet during rolling.

Progress has been made in the past year in the production of higher voltage X-ray equipment. Since the introduction of 1,000,000-volt X-ray units several years ago by one manufacturer, other companies have entered this field. It is reliably reported that one company is ready to market a unit in the multi-million volt range based upon the Van de Graaff generator and using a sealed off tube.

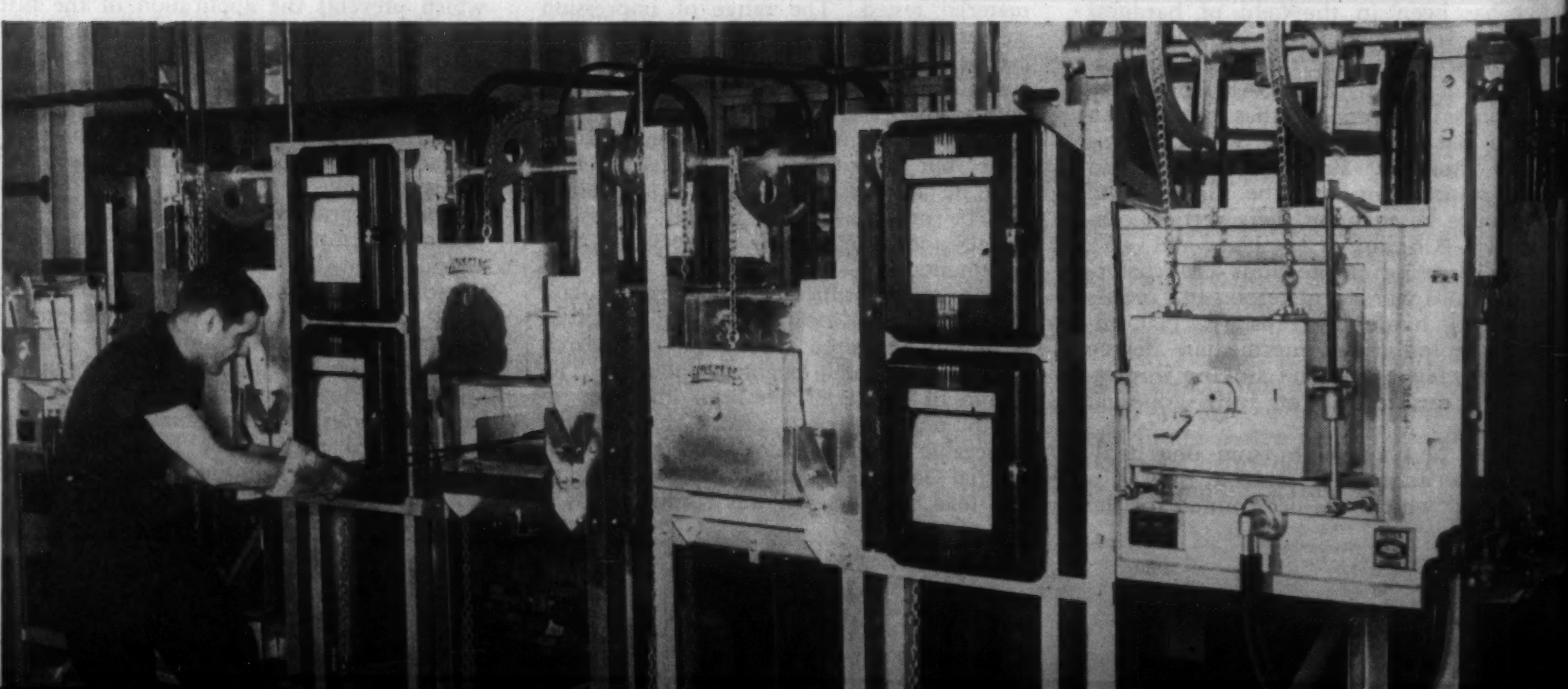
Delivery of 2,000,000-volt X-ray units by the General Electric X-Ray Corporation has been made recently. The design is essentially the same as their original 1,000,000-volt units, except for size.

The X-ray tube is made up into 24 sections and is 9 ft. long. No performance data have been published, but information from the manufacturer has indicated an exposure time 1/78th of that with the 1,000,000-volt unit for steel sections 8 in. thick.

The X-ray profession is still waiting to hear the last word on the practicability of the Betatron for radiographic purposes. Betatron, as an electron accelerator, can produce an X-ray beam equivalent to twenty million volts, or higher. Some surprising results can be obtained at this voltage, such as absence of scattered radiation and a realization of absolute sensitivity. The size of the Betatron unit, as well as the very narrow X-ray beam produced, will probably limit its application to any but the most specialized industrial problems.

Considerable publicity has been observed in technical publications on the design and application of fluoroscopic X-ray units. Considerable success has been achieved in this application in the die casting field. The die casting application is unique, however, in that the type of defect usually encountered is readily detected by fluoroscopic examination. Extensive application of fluoroscopy to aluminum and magnesium castings used in stressed sections appears remote, although occasional applications may be justified. The best estimate of sensitivity obtainable under ideal conditions is 4% and, practically, in commercial applications, it averages 6% or more. It is hoped that further developments can improve this process as it has much to recommend it as a low cost inspection method.

One company's testing laboratories contain a set of heat treating furnaces for testing steels



A versatile four-range comparator for dimensions

Checking the Rockwell hardness of hardened steel bars

Electronic and Electrical Inspection

by KENNETH ROSE, Engineering Editor, METALS AND ALLOYS

An important step in improving a piece of work is the testing of the work to determine when an improvement has been made, and how much. It is natural, therefore, that the demand for stronger materials, more uniform materials, better fabricated parts, closer tolerances, greater precision of every sort would produce new testing instruments to measure this precision. The year just past has seen an unusually large number of such devices introduced to industry. Because of the high accuracy possible in electrical measurements, many made use of electrical or electronic principles.

Measurement of thicknesses in inaccessible parts of a structure has always been a serious problem for the inspector and the test engineer. The Sonigage, developed by General Motors, offers a solution. Measuring the frequency at which a metal section vibrates when in contact with an oscillator, the resonance frequency is converted to a linear measurement, with an error of less than two per cent. The applicable range of the device is at present about 0.020 in. to 0.400 in.

The Ferrograph, a sister instrument to the now-familiar Cyclograph, entered the field of metal-identifying equipment making use of core loss, magnetic, or similar characteristics very accurately determined. Another identifying device makes use of the principle of the thermocouple by bringing the sample into contact with a known metal bar, and determining the electromotive force produced, if any.

The smoothness of bearing races has been evaluated by amplifying the hum of the bearing in test runs. The Vibrograph, recording the vibration of a part under test, permits an analysis of the curve so produced. Another type of instrument records the strength of flux of magnets, a determination of prime importance in calibrating certain types of meters.

The dynamics-measurement field has been especially prolific. Many of the new instruments in this field have been developed to meet needs in aircraft testing, frequently by the research laboratories of the aircraft companies themselves. The Glenn L. Martin Co. has announced a dynamics measurement set using electronic amplification of impulses from a special pickup unit, having a frequency range of zero to 3600 cycles per minute, and adjustable to other frequencies. Designed for flight testing, it is applicable to determination of structural stresses, accelerations, pressures, and displacements in such varied fields as bridges, buildings, automobiles, ordnance, or fluid dynamic pressures.

The electronic tube, to provide amplification of the very faint signal, is combined with the electric strain gage in many of these new electric testing units. Results may then be recorded by electrical metering devices, or by the cathode-ray tube, or by a suitable oscillograph. In an automatic recording instrument developed by Republic Aviation Corp. results of load testing, in either tension or compression, are automatically plotted as a load-deflection curve during the test.

The new electric and electronic testing equipment shows new combinations or new adaptations of familiar units rather than radical departures from existing techniques.

Metallography

by CARL A. ZAPFFE, Rustless Iron & Steel Corp., Baltimore, Md.

Principal technological advances in metallography in 1944 concern improvements in three fields: Electron microscopy, microradiography, and color photomicrography, and the development of a new field called fractography.

For *electron microscopy*, the announcement of two new microscope models by RCA and one by General Electric is of first importance. These new instruments take the electron microscope out of the steam engine class and make it an instrument now operable with moderate patience. A principal advantage lies in permitting the lenses to be cleaned within fifteen minutes.

Among improvements in technique, stereoscopic viewing by the Polaroid vectograph process, developed at the Dow Chemical Company, deserves special mention, as does the technique of anodic oxidation developed in the Aluminum Research Laboratories, and dark field illumination, studied at Schenley Research Institute. Since resolution exceeds fineness of etch in electron microscopy, recent effort is toward improving etching and replica methods, electrolytic etching rapidly becoming favored.

Microradiography, though invented earlier, gained full stature as a metallographic tool through its development at the Chase Brass and Copper Company and the Picker X-Ray Corporation. The technique requires the use of fine-grained film and characteristic X-radiation of intermediate wave length.

Based upon the principles of X-ray absorption, microradiographs are three-dimensional in effect and can be useful at magnifications of 100 diameters in revealing structural heterogeneities not otherwise visible, such as the true shape of inclusions, and also compositional heterogeneities, such as the concentration change within a solid solution, or the distribution of elements in polyphase alloys. Application of the newly developed high-speed radiography to microradiography is unknown.

Color photomicrography received a strong impetus from the excellent article by Loveland (in ASTM *Bulletin* for May 1944) and from the recent marketing by Ansco of color film capable of home-processing. Colored slides of microstructures are now conveniently made. That the results are instructive and promising, especially when using polarized light, has been proved in the laboratory where the writer works.

Fractography is a new metallographic technique developed at the Rustless Iron and Steel Corporation for examining the detail on fractured surfaces. A simple orienting device brings an individual cleavage facet into focus on the microscope, any interfering promontories being first removed with a small hand-grinder.

The method is applicable to any cleavage surface, is best for brittle metals, and permits observation of structures never before studied. Besides serving as a supplementary metallographic tool in identifying constitution and in studying single crystals in polycrystalline aggregates, fractography is expected to permit direct observation of the long discussed imperfection or "mosaic" structure of crystals.

In closing, mention might be made of Tolansky's interferometric procedure for the examination of crystal surfaces in which a thin silver film is sublimed upon the facet and upon a good optical flat. A parallel beam of light from a small circular aperture illuminated by a green-filtered mercury arc is directed at normal incidence upon the silvered faces, forming fringes which are true contour lines of the crystal's surface. Also meriting mention is McDill's "Faxfilm," a three dimensional replica for surface inspection which can be enlarged to 100 diameters and can be prepared in less than a minute at a cost of six cents per print.

Surface Roughness Testing

by JOHN M. TRYTTEN, Physicists Research Co., Ann Arbor, Mich.

With the general use by industry of standard instruments for measuring surface roughness, manufacturers individually have been successful in solving their surface-roughness problems. This is particularly true in connection with war production.

The importance of waviness, however, is coming to be more widely realized. Roughness and waviness irregularities are arbitrarily distinguished at being respectively more closely or more widely spaced than 1/32 in. Manufacturers are becoming more and more concerned with surface irregularities spaced horizontally from about 1/32 in. to ½ in. peak-to-peak.

Since these irregularities were beyond the range of the usual surface-roughness measuring instruments, two new instruments were developed for measuring them.

For giving an average roughness figure similar to a Profilometer reading, a Roughness Meter has been designed. The Roughness Meter resembles the Profilometer, and works on the same principle. The fundamental differences are in the use of higher tracing speed and a blunter tracing point.

The reading produced by this instrument is in microinches of average roughness of the surface, and its applications are particularly in the production inspection of such surfaces as high-explosive, large-caliber shells, and the roughness of which is often in or near 1/32 in. peak-to-peak range.

For the accurate measurement of waviness up to ½ in. or more (peak-to-peak spacing), a displacement recorder known as the Recordagage has been offered to industry. This recorder makes a profile of the actual configuration of surface irregularities including the larger roughness, waviness, eccentricity, and other displacements of all sorts.

The Recordagage is a recording-type instrument, with the reading or profile appearing on a continuous chart. Magnification vertically is 2500X; horizontally, magnification is controlled by the tracing speed in relation to chart speed.

The application of these and other roughness measuring or analyzing instruments to manufacturing problems promises to indicate the highly important effects of waviness, tool chatter, etc., on the performance of machined parts.

Statistical Quality Control

by J. V. STURTEVANT, Carnegie-Illinois Steel Corp., Pittsburgh

The industrial use of modern statistical control consists essentially in applying simple statistical relationships to the study of the variations in quality and cost which are inherent in any manufacturing process. A second and equally important application is for determining whether a lot of articles shall be accepted, when a random sample drawn therefrom has been inspected on the familiar "go—no go" basis. Pioneered from the early twenties by Dr. W. A. Shewhart of the Bell Telephone Laboratories, the use of these methods has spiraled in increasing extent until today many hundreds of manufacturers are using them to improve quality and uniformity while at the same time costs of production and inspection are lowered. This increase in the practical use of statistical control seems to rest upon three primary bases:

First:—During the past few years, the technique of these methods has been so thoroughly simplified that the usual clerical personnel, working under a trained supervisor, can efficiently carry on extensive programs of quality control. The result of this simplification has been to improve the understanding of the methods and to broaden and intensify their application.

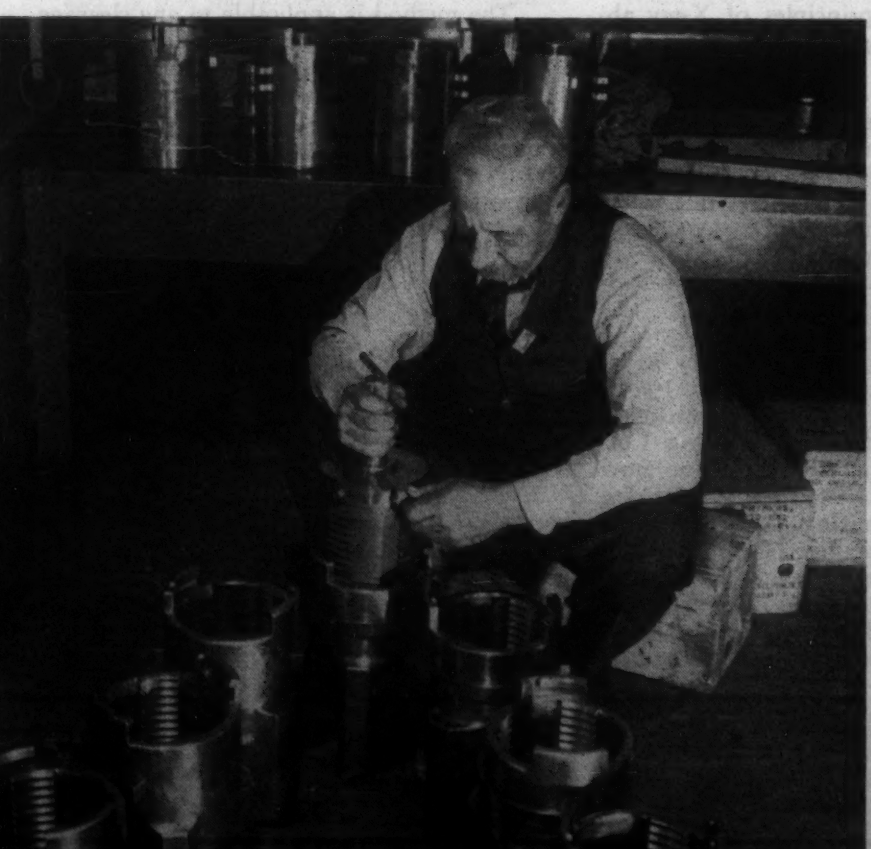
Second:—Under the pressure of war needs for increased production and lowered inspection losses, the Statistical Division of the War Training Program has sponsored an extensive series of statistical quality control courses in centers of war activity throughout the United States. The graduates of these courses, now numbering in the thousands, are banded together into more than twenty Quality Control Societies throughout the country. Each group holds frequent meetings for discussion of both the elementary and advanced aspects of the statistical technique.

Third:—Considered from the "proof of the pudding" point of view, the most important reason for the increasing activity in statistical control lies in its successful application. Examples of the various fields into which statistical control has been profitably introduced in the past four years are: aircraft manufacture, machining of parts, production of electronic equipment, loading of munitions, textile weaving, glass manufacture and inspection of many articles purchased by our armed forces.

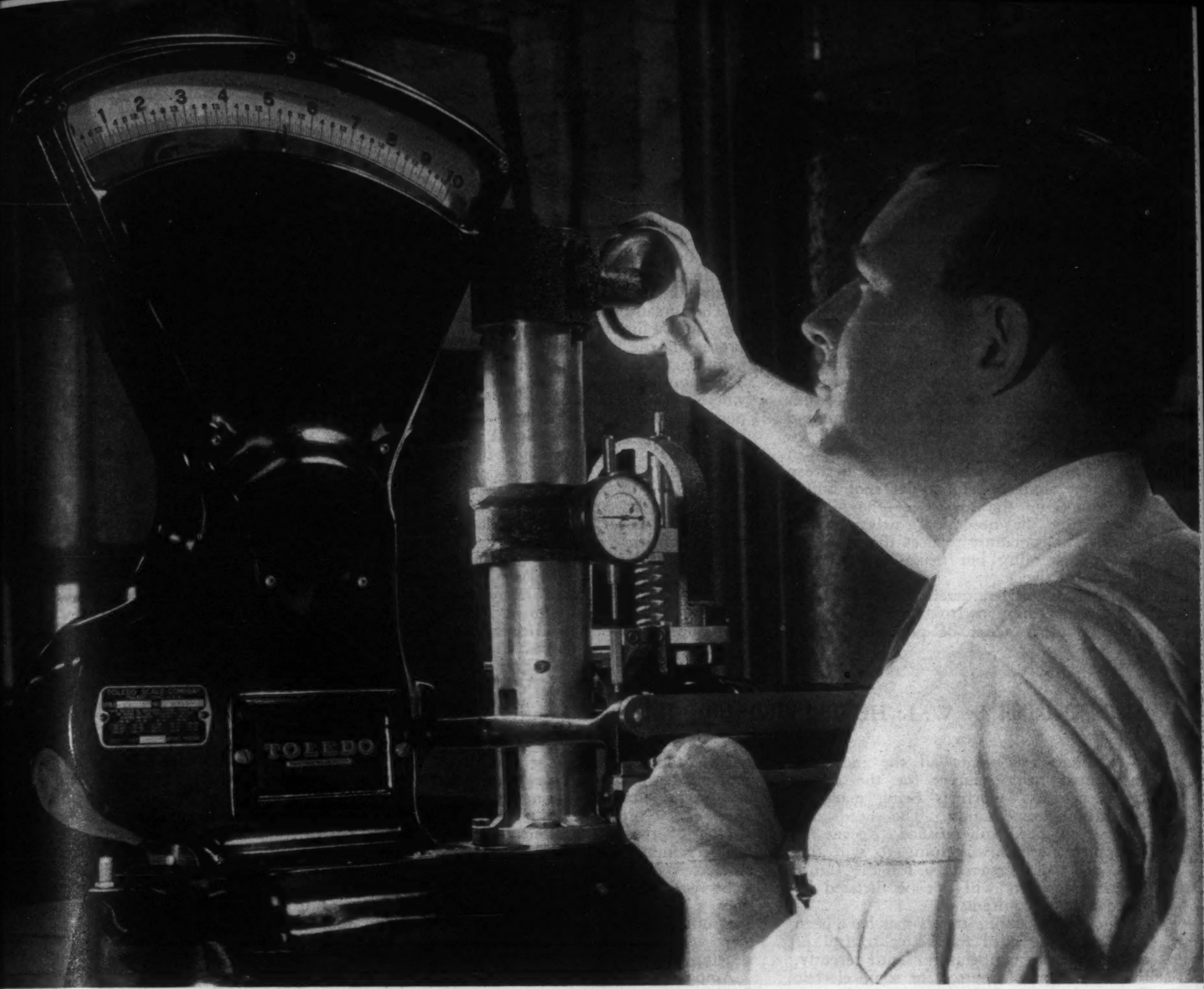
Specific developments during the past four years include (1) the use of the much simpler "Range" instead of the earlier "Standard Deviation" in determining the dispersion of small groups; (2) the measuring of control limits from the specification limits instead of from the average line in machine tool work; (3) the widening recognition that the control chart can be used to determine whether a given process can economically meet a given specification and (4) the application of the group control chart to the problem where several similar units are producing the same article.

More recent developments, certain to be of interest in the post-war years are: (1) the review of specifications for the purpose of placing them on a statistical basis to the mutual advantage of customer and supplier and (2) the development of the Sequential Sampling Plan now being used by certain divisions of the armed forces. While war restrictions prevent publication of this plan at present, its advantages in inspection sampling on the "go—no go" basis are expected to place it in the limelight in post-war years.

Inspecting breech rings with a special gage



Testing the "drift" of springs with an electronic micrometer



Spring tension or compression is checked by one company using a converted ordinary store scale

Stress Analysis

by O. J. HORGER, Timken Roller Bearing Co., Canton, O.

Adequate performance of stress carrying members presumes a knowledge of both the stresses occurring in service and the strength characteristics of the material. The penalty for empirical rather than rational considerations in design too often results in either failure in service or overdesign.

The expanding aircraft program is responsible for the greatest advances being made in methods of stress analysis. Problems of maximum strength with minimum weight require an accurate knowledge of stresses. It is estimated that saving of one pound of weight on a plane is worth up to a value of $80.00. One railroad authority projects the thought that one could afford to pay as much as 10 cents per pound of weight saved in freight cars and $1.00 per pound saved in passenger cars and locomotives.

The function of a stress analysis may be to determine the magnitude of stresses, stress distribution, critical or buckling loads, and/or modes of vibration. The small and light weight electric wire resistance strain gage, which is cemented to the surface of a member, has contributed most toward the rapid progress made in stress analysis.

Photoelasticity and brittle coatings offer excellent means of determining local stress concentration. Also brittle coatings simplify the means of finding the direction of stresses so that strain gages may be located to better advantage. Photographic methods of printing grid patterns on the surface of stampings facilitates the study of strain distribution in deep drawn parts. The wire resistance gage and photogrid permit studies in the plastic region where our knowledge is inadequate.

Real advances have been made in the development of multiple channel recording oscillographs for use in the determination of stresses under dynamic loading. Dynamic strains have been recorded for the determination of loads on an airplane traveling near the speed of sound, hammer rods on forging hammers, railroad track, and guns during firing. For aircraft use a short wave transmitter is sometimes used to automatically send the strain indications to a ground receiving station; this relieves the plane of added weight, leaves the pilot free for attention to flying duties, and in case of plane accident a record is available of its performance.

When strains are measured in several directions, as in a rosette, it becomes a labor and time consuming operation to compute the principal stresses and maximum shearing stress. Ingenuity has been extended to rapidly solve these independent strains electrically by electronic computing analyzers.

Processing operations of shot peening, surface rolling, flame and induction hardening, and some types of quenching and tempering leave the design members with certain residual or internal surface compressive stresses. Many examples can be found of production parts where the fatigue resistance is considerably increased by the presence of such residual stresses. Also the welding industry is giving attention to the influence of residual stresses because of the failure of certain structures, such as ships.

While the methods and equipment for stress analysis may still be greatly improved the present state of the art is possibly further developed than the capacity of many engineering departments to apply these methods. There are entirely too many obsolete concepts, beliefs, and personal bias existing among engineers that handicap the open mind required for engineering progress.

Spectrography by J. D. GRAHAM, International Harvester Co., Farmall Works, Rock Island, Ill.

Recent developments in spectrography are plentiful due to its youth—or rather the brevity of its industrial acquaintance. 1944 has seen a widening acceptance of this analysis method in ferrous fields (its non-ferrous applications are now taken for granted).

A new method, "Flat-surface sparking," is the chief reason for the advancement of ferrous spectrography. This method has for some time been used for aluminum and magnesium but only recently has been applied to iron and steel. It consists in producing the analytical discharge between a carbon electrode and a flat spot buffed or ground on the surface of the sample, eliminating the need for costly machine work. This not only reduces the time and cost of sampling but makes the method non-destructive.

A prominent equipment development is the direct-reading spectrograph. This instrument employs a set of photo-cells, each adjusted to respond to a certain spectral line. By means of amplifiers and counters, the instrument obtains intensity ratios directly without the use of photographic film.

This greatly increases the speed of analysis, and eliminates many steps such as processing the film and construction of the gamma curve, which may introduce errors. This equipment should be very valuable where speed of analysis is of upmost importance, but the cost will be considerably higher than the conventional type. The instrument may be available by the time this is published.

The trend in power supply equipment is toward an all-purpose unit which will deliver a wide variety of excitation currents, thus eliminating the need for several machines, and the attendant time and bother of changeover. Several power units of this type are available, with many interesting features designed to improve stability and reproduceability of the discharge.

Electronic exposure control utilizing a light measuring circuit instead of time has done much to improve the accuracy of results. A control unit in conjunction with an electric shutter over the slit starts exposure after any chosen pre-burn time, and stops exposure after a predetermined amount of light has been emitted by the analytical discharge.

The spectrograph is comparative—its quantitative results can be no better than the standards with which it is calibrated. Non-ferrous standards have been available for some time, but the National Bureau of Standards has recently begun supplying steel spectrographic standards for all the common alloys involved in ferrous work, including boron. The determination of boron percentages in steel has been very difficult and in most cases of questionable accuracy. With the Bureau's boron standards, any of the recognized industrial spectrographs can be set up to give rapid, accurate boron analysis.

Instrumentation by W. L. HUNT, Automatic Temperature Control Co., Inc., Philadelphia

Our hats are off to all the industrial instrument manufacturers for the exceptional progress which is being made in general instrumentation. The needs are being recognized and satisfied. Recent developments are now helping to win this war, and hold great hope for the future when our efforts will not be dictated by more urgent requirements.

One of the definite trends that have been faced was the need for better control of electric furnace temperature. Until recently, the only form of control for some electric furnaces had already been found inadequate by those working with fuel-fired furnaces. The floating control systems had offered the only method of obtaining fair temperature regulation, and there was an emphatic need for more accurate results when dealing with more critical applications. True proportioning control with automatic reset, well established for control results on fuel-fired furnaces (and especially for the very fussy controlled-atmosphere types) is the answer, and several such instruments are now available.

One of these controllers, an electronic balancer input controller for precise control of electric furnace temperature, is expected to be very successful, but beyond that underlines a distinct trend toward the use of electronic control mechanisms because of their accurate automaticity, freedom from wearing and moving mechanical parts, etc.

Among other useful new instruments are flexible signalling timers to withstand rugged industrial use, and replace the traditional alarm clock, and new manually-set input controllers or rate controllers to provide high accuracy in setting a repeating percentage-on, or duration-controlling timer, especially valuable in obtaining program control of temperature or "time-temperature control."

The outstanding trend in the entire instrumentation field has been the continuing increase in the application of instrumentation itself. Automatic operation of open hearth combustion and reversal systems, air-weight control of cupolas, flow control of fluids in metal-working and other processes, ingenious systems for analyzing and recording furnace atmosphere compositions and changes, flue gas analyses, complete removal of air from furnaces before firing, furnace-pressure control, etc., have all been extended through development and application of more efficient control instruments specially engineered for those purposes.

For the present, instrumentation progress has served primarily to maintain product quality with a minimum use of critical manpower. Tomorrow the same instrumentation will be employed in addition to cut costs in the more competitive industrial world that lies ahead.

Hardenability Testing by W. E. JOMINY, Dodge Chicago Plant, Chrysler Corp., Chicago

Interest in hardenability testing has become more widespread during the past year. A proposed method of purchasing steel by the use of hardenability bands is receiving a great deal of attention. This involves dividing steels into groups or bands which have hardenability within certain limits on the end cooled bar and specifying steel within these limits.

It is expected to keep the same types of steel but to permit a somewhat greater latitude in the chemical composition with the exception of carbon. It has been pointed out by J. Mitchell that fewer rejections are likely if this method of specifying and purchasing steel is used. This method of specifying steels represents a departure from convention and many engineers and metallurgists will probably look askance at this proposal. If intelligently applied, however, it appears to be a forward step.

Already one specification has been written and accepted as an SAE standard with a limitation on the hardenability as measured by the end cooled method. This specification is AMS 6342 issued November 1, 1944. If steel is purchased on the basis of hardenability bands it is important to have the bands of such widths as to be practical from the standpoint of steel production and yet permit uniformity of product which is satisfactory to the user. The user must be certain that the hardenability band chosen allows proper hardening in the parts for which the steel is intended and this must be determined with the steel in the as quenched condition and not after tempering.

A question which has been the subject of much debate is whether a part should be hardened through to the center before tempering or whether a soft center and a hard outside is desirable. If a soft center is permissible, it will be possible to use a steel with lower hardenability than if a hard center is required. Economics may dictate which type is adopted since the lower hardenability steel has less alloy.

If a soft center and a hard outside is obtained with the steel on the low side of the hardenability range, then with many parts the center will be hard if the steel is on the high side of the hardenability range. Whether this variation in center hardness will cause much trouble from distortion perhaps depends upon the design of the part. However, if steel is chosen for parts which will give a soft center, there is bound to be a variation in the center hardness with commercial variation in the hardenability of the steel.

These things must be considered in specifying the hardenability of steel whether by composition or hardenability bands.

METALS and ALLOYS

Engineering File Facts

NUMBER 66
January, 1945

METHODS AND PROCESSES
Casting Methods

Metal Casting Methods

The casting process is fundamental to all industry. Practically all metal cast into ingots is at some time in its process of purification from ores. Even steel intended for forging or rolling starts as a casting.

Casting methods are basically simple—filling a mold of the desired shape with molten metal, and permitting it to solidify. Amazing ingenuity has been shown in adapting this simple procedure to production of extremely complicated forms, and to high-production techniques, so that the casting process is the most versatile of the metal forming methods.

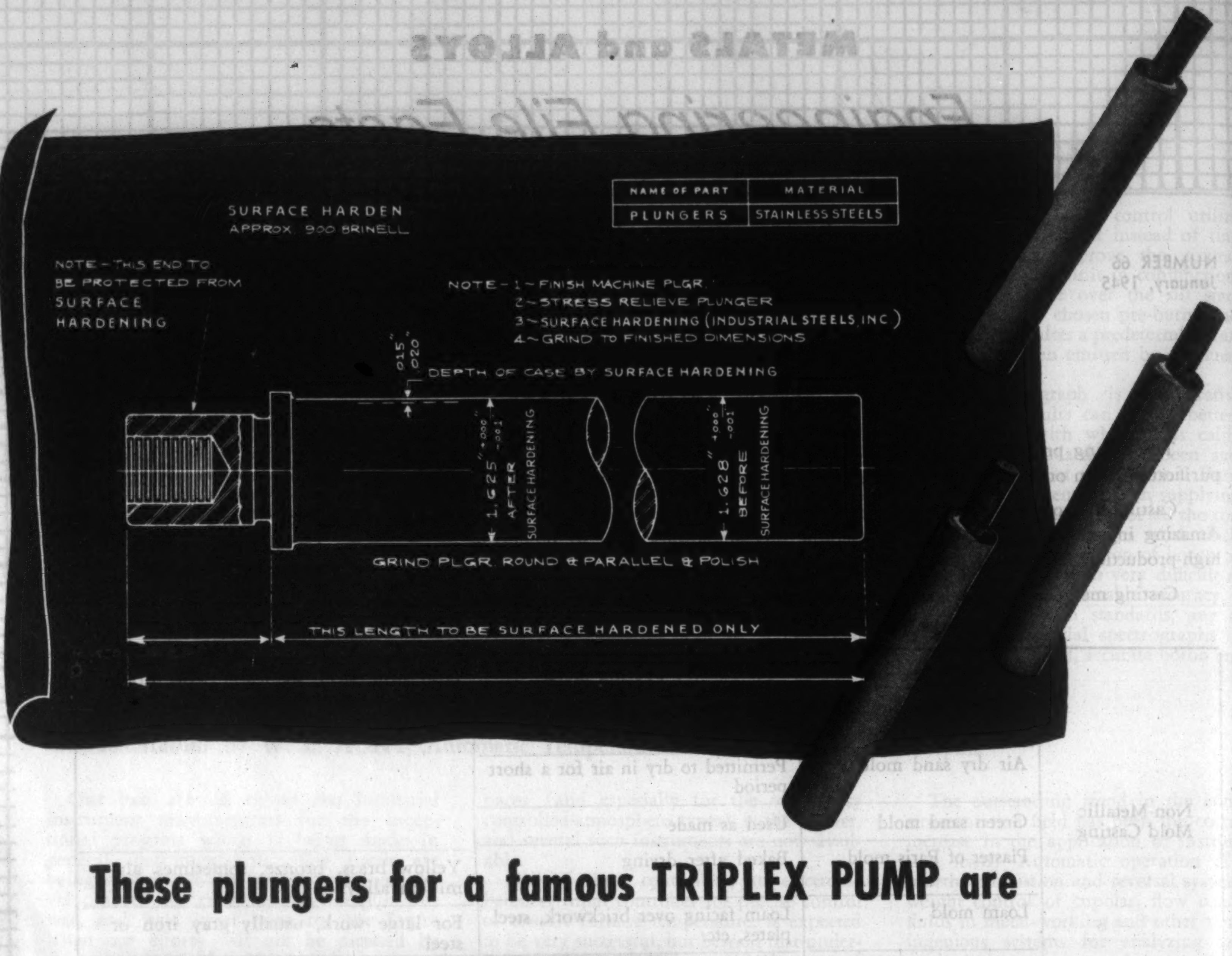
Casting methods may be classified on the basis of mold composition into non-metallic mold casting and metal mold casting:

Non-Metallic Mold Casting	Dry sand mold	Baked before pouring metal	Gray iron, steel, malleable iron, brass, bronze, aluminum alloys, magnesium alloys
	Skin dry sand mold	Mold face dried with a gas torch, etc.	
	Air dry sand mold	Permitted to dry in air for a short period	
	Green sand mold	Used as made	
	Plaster of Paris mold	Baked after drying	Yellow brass, bronze, sometimes aluminum alloys
	Loam mold	Loam facing over brickwork, steel plates, etc.	For large work, usually gray iron or steel
	Wood, paper, rubber, etc., molds	Special techniques to fit particular application	Primarily for the low-melting alloys, as type metal, Wood's metal, etc.
Metal Mold Casting	Permanent mold	Steel molds, refractory coated—for iron Iron or steel molds—for aluminum alloys, bronzes, magnesium alloys Bronze molds—lead and other low-melting metals	
	Semi-permanent mold	Metal molds, with sand cores	Same metals as for permanent molding
	Die casting	Metal injected into die under pressure from machine containing reservoir of molten metal	Zinc and zinc alloys, aluminum alloys, lead and tin alloys, magnesium alloys
	Cold-chamber pressure casting	Metal injected into die under pressure from separate reservoir	Copper alloys, aluminum alloys, zinc alloys, magnesium alloys
	Centrifugal casting	Sand-lined mold or permanent mold	Steel, gray iron, copper alloys, Babbitt metal, etc.

Second only to mold composition is the type of pattern equipment. Development of new types of patterns has been largely responsible for the position of the modern foundry as a high-production shop. Patterns may be classified as:

Single, loose patterns	Wood or metal	Low first cost, but suitable for only limited production
Gated patterns	Wood or metal	Cost of cutting gates by hand is saved
Matchplate patterns	Metal	For producing small parts in large quantities
Cope and drag patterns	Wood or metal	For production with medium and large castings—cope and drag can be made up simultaneously
Sweeps, skeleton patterns	Wood or metal	For use as guides in making molds for very large castings, or for complicated pieces not required in quantity
Wax, fusible metal, etc. patterns	For special techniques in which elaborate coring would be required, or pattern withdrawal would be difficult. Primarily for small parts	

Compiled by Kenneth Rose, Engineering Editor


NAME OF PART | MATERIAL
PLUNGERS | STAINLESS STEELS
SURFACE HARDEN
APPROX. 900 BRINELL
NOTE - THIS END TO BE PROTECTED FROM SURFACE HARDENING
NOTE - 1 ~ FINISH MACHINE PLGR.
2 ~ STRESS RELIEVE PLUNGER
3 ~ SURFACE HARDENING (INDUSTRIAL STEELS, INC.)
4 ~ GRIND TO FINISHED DIMENSIONS
.015"
.020
DEPTH OF CASE BY SURFACE HARDENING
1.625" +.000 -.001 AFTER SURFACE HARDENING
1.628" +.000 -.001 BEFORE SURFACE HARDENING
GRIND PLGR. ROUND & PARALLEL & POLISH
THIS LENGTH TO BE SURFACE HARDENED ONLY

These plungers for a famous TRIPLEX PUMP are

SURFACE HARDENED *before* finishing!

The necessity for close tolerances means that certain areas of these stainless steel plungers must be carefully finished *after* they have been surface hardened. Thus, selective hardening treats these critical areas to a depth of .020", which allows for subsequent grinding and polishing to exact finished dimensions.

Not only must the finished plungers fit accurately, but they must also be able to withstand severe conditions of abrasion and corrosion. Each plunger is subjected to the tremendous binding friction of a stuffing box capable of holding 1250 p.s.i. of hydraulic pressure, and the plunger surfaces are constantly exposed to the corrosive action of water, or other media being pumped.

These dangers are successfully met by the INDUSTRIAL SURFACE HARDENING PROCESS, which provides stainless steel with a "glass-hard" (91 to 97 Rockwell 15-N) surface. Thus, abrasion resistance is combined with the natural immunity to corrosion possessed by stainless steel.

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METALS and ALLOYS
Engineering File Facts

NUMBER 67
January, 1945

Corrosion Protection for Magnesium Alloys

While the best of the present commercial magnesium alloys have satisfactory corrosion resistance under ordinary inland atmospheric conditions, it is customary to give magnesium parts a protective treatment. These protective films, in addition to fulfilling their prime purpose of resistance to corrosion, also provide an excellent surface for painting.

Surface attack occurs as a uniform etching, with the metal gradually darkening and acquiring a thin film of magnesium hydroxide or carbonate. The film retards rather than prevents subsequent attack.

Magnesium alloys are especially subject to attack by water with a high chloride content. They may corrode rapidly when immersed in salt water, or when wet with salt solutions for substantial periods of time, unless properly protected.

Since even perspiration will attack magnesium in a matter of minutes, many companies give castings a dip in a light oil or slushing compound immediately after cleaning.

Magnesium corrosion protective treatments are of nine principal types: (1) chrome-pickle treatment, (2) sealed chrome-pickle treatment, (3) dichromate treatment, (4) galvanic anodizing treatment, (5) chrome-sulphate treatment, (6) chrome-alum treatment, (7) modified alkali-chromate treatment, (8) borax, and (9) caustic-pressure treatment.

The first is used for temporary storage, domestic shipment, bonding, touching-up of previously treated work, and for brush application when this is permissible. It is not suitable when close dimensional tolerances are required, since the amount of attack is considerable. When protection must be assured for a longer period, the sealed chrome-pickle treatment is used. If the parts are so sized that the metal removal occurring by either of the chrome-pickle treatments cannot be permitted, the dichromate treatment may be used with all but manganese-magnesium alloys. It will give long-time protection with negligible change in dimensions. For the manganese-magnesium alloys, galvanic anodizing is used. It likewise causes little metal loss.

Treatment with chrome-sulphate is used where low electrical resistance is a prime requirement. When die casting alloys are to be given a decorative black finish, suitable for indoor use, the chrome-alum treatment is used. Good protection against salt water corrosion, with negligible dimensional change, is characteristic of the modified alkali-chromate treatment, while the borax treatment offers a hard, decorative film. When resistance to abrasion is an important factor, the caustic pressure treatment may be used. The last two films, being grayish in color, can be dyed to produce decorative finishes.

Before using any one of the protective treatments, the metal surface must be thoroughly cleaned. All grease, oil, oxide film, casting skin, paint, or welding flux must be removed. Grease and oil may be removed by the use of organic solvents, or by vapor degreasing. When liquid solvents are used, the work should be given a final rinse in clean, unused solvent.

Oxide films, casting skin, and previously applied paint or other finish may be removed by abrasive equipment. On sheets and extrusions, sanding, wirebrushing, or scrubbing with steel wool will give a satisfactory cleaning. Rough unmachined castings may be sandblasted or cleaned in a nitric-sulphuric acid pickle. Machined parts are best cleaned in a chromic acid bath.

Old paint is removed by scraping, sanding, or with an alkaline liquid paint remover, such as caustic soda solution. If a solvent-type paint remover is used, it should be followed by a wash with a wax-free solvent. Sandblasting will remove old paint coatings from heavy parts.

Welding flux is removed with hot water and a wire brush. Where the areas cannot be reached with a brush, a high-velocity jet of water may be used.

A joint specification issued by the Army and Navy, AN-M-12, requires that all chemicals used in cleaning and treating magnesium be free from salts of heavy metals. A final cleaning in a strong alkali cleaner, similar to those used for steel, is demanded just prior to the surface treatment.

The nitric-sulphuric acid pickle, used for the cleaning of sand castings, is used with sandblasted parts and with those showing surface oxidation also. It must be used before machining, however, as an appreciable amount of metal is dissolved. In using the pickle, the work is immersed in it for a period of 10 sec., then rinsed thoroughly in running water, and finally dipped in hot water to speed drying.

Composition of the nitric-sulphuric acid pickle is:

Sulphuric acid, concentrated, 2 parts by volume
Nitric acid, concentrated, 8 parts by volume
Water, 90 parts by volume

The chromic acid bath for use with machined parts is composed of 1½ lb. of chromic oxide, CrO_3, per gallon of water. Parts to be cleaned are immersed in the bath for about 15 min. at room temperature, or for one min. at 200 F.

Chrome-Pickle Treatment—AN-M-12 Type 1

In using the chrome-pickle treatment, the work is immersed for from ½ to 2 min. in a bath of the following composition:

Sodium dichromate	1.5 lb.
Nitric acid	1.5 pints
Magnesium sulphate	0.2 lb.
Water, to make	1.0 gal.

The bath is used at room temperature. The magnesium pieces are then exposed to the air for five sec., and washed in cold running water, followed by a dip in hot water to assist in drying. Welded sections should be allowed to remain in the solution somewhat longer, and agitation is used during immersion.

When removed from the wash water, the work has a red-and-yellow iridescence. If it should show a bright yellow coloration, an excess of nitric acid in the bath is indicated.

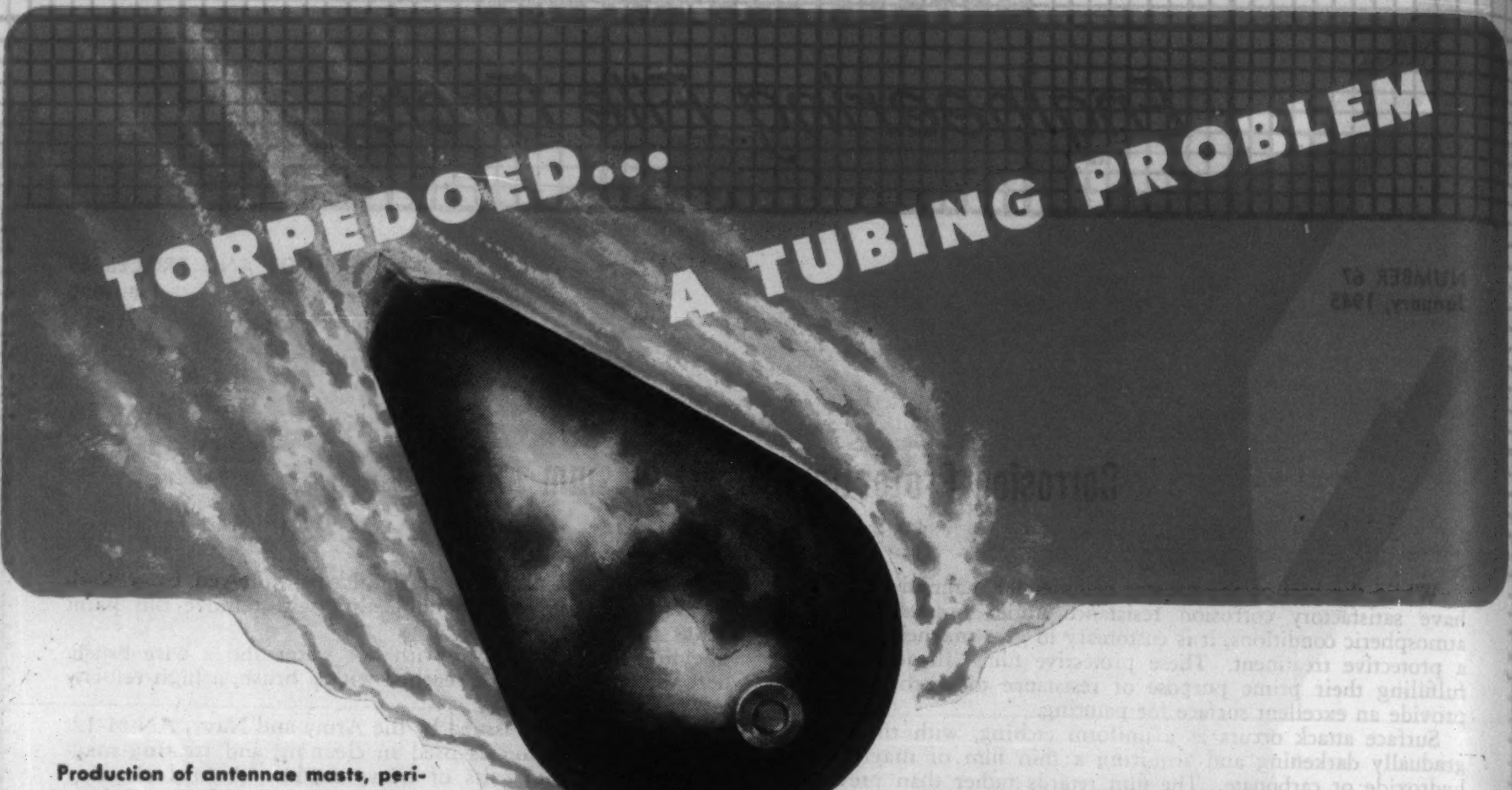
Sealed Chrome-Pickle Treatment—AN-M-12 Type 2

For the sealed chrome-pickle treatment, parts from the chrome-pickle treatment are immersed for 30 min. in a boiling solution composed of:

Potassium or sodium dichromate, 10 to 20% by weight
Magnesium or calcium fluoride, 0.25% by weight
Water, remainder

Hot and cold water rinses follow the chemical treatment. Joint Specification No. AN-M-12 provides that the treatment must follow immediately after the chrome-pickle film. It also re-

(Continued on page 149)



Production of antennae masts, periscopes, and drive shafts caused serious bottlenecks in the overall output of submarines. On one of these items — antennae masts — a 40', corrosion-resistant, stainless alloy steel tube weighing 1450 lbs. was needed. *Up until two years ago 1000 lbs. was tops for commercial production of stainless steel tubing.*

The Babcock & Wilcox Tube Company "torpedoed" this problem by:

- **developing a new simple, ingenious mill operation by experimentation.**
- **producing the largest individual pieces of stainless steel tubing ever made in this country *in production quantities.***
- **speeding production by the B&W method—15% faster than the time required by forging methods.**
- **meeting the extremely rigorous requirements that are shown on this page.**
- **following through by using a special method of packaging which insured safe delivery.**

Thus, from the presentation of this problem all the way to delivery, it was a typical B&W Tube job . . . not an extraordinary accomplishment. Rather, we would like to have you feel that if you have a tubing problem the same B&W facilities and skill which proved successful in this instance are at your disposal.

THE PROBLEM

to manufacture commercially—a stainless-alloy-steel tubing

40' in length
6" in diameter
.600" wall
1450 lbs. in weight

SPECIAL REQUIREMENTS

withstand same hydrostatic pressure as body of submarine—

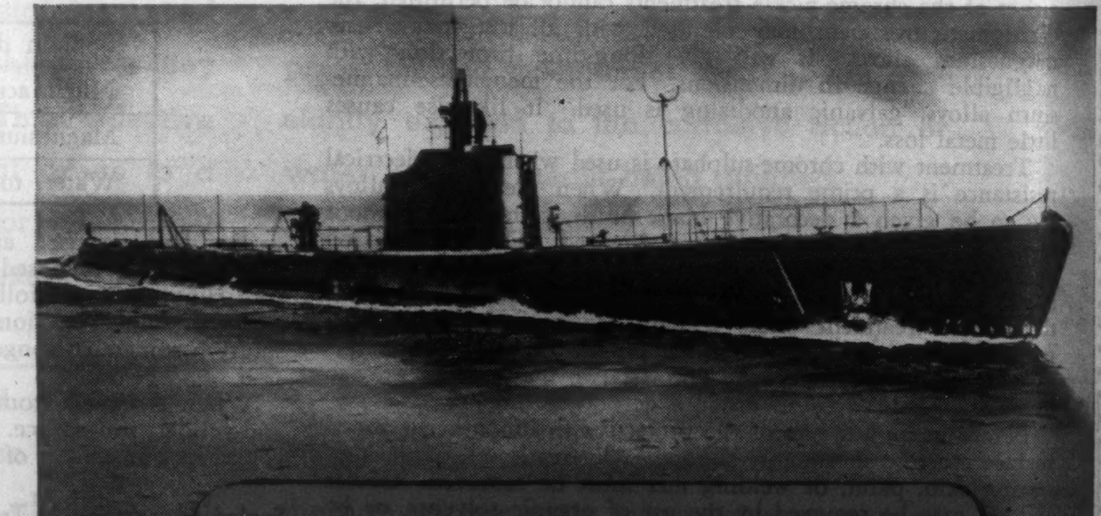
must be non-magnetic—

corrosion resistant to high degree—

absolutely straight—must be projected up and down through a stuffing box—

exceptionally close tolerance, as antenna mast must be machined to within .022".

IF YOU THINK WE CAN HELP YOU, WHY NOT WIRE, PHONE OR WRITE NOW?



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Sizes: 1/2 in. to 8 5/8 in. O.D.
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TA-1308

NUMBER 67 (Continued)

CORROSION PROTECTION FOR MAGNESIUM ALLOYS

quires that parts shall be painted immediately after becoming completely dry following the rinsing.

Dichromate Treatment—AN-M-12 Type 3

In applying the dichromate treatment, the parts to be treated are immersed for 10 min. in a 15 to 20% solution of hydrofluoric acid by weight, used at room temperature, then rinsed thoroughly in cold running water, and dipped in hot water to speed drying.

A 5% solution of sodium acid fluoride, potassium acid fluoride, or ammonium acid fluoride may replace the hydrofluoric acid bath, provided the work has not been sandblasted. The substitute bath requires 15-min. immersions at room temperature.

Galvanic Anodizing—AN-M-12 Type 4

When using the galvanic anodizing treatment, the work is given the hydrofluoric acid dip as in the preceding method, rinsed thoroughly in cold water, then suspended in a steel tank or a tank containing steel cathode plates, in the following solution:

Ammonium sulphate	4 oz.
Sodium dichromate	4 oz.
Ammonia	⅓ fl. oz.
Water, to make	1 gal.

The magnesium parts are externally connected to the steel by electrical connectors, and a current not exceeding 10 amp. per sq. ft. of anode is passed, and maintained for about 30 min. To obtain a satisfactory coating, the treatment should be about 70 amp.-min. or more.

Either the dichromate or galvanic anodizing treatment may be applied to work previously chrome-pickled, or to assemblies containing brass, bronze, cadmium or steel. Aluminum inserts are rapidly attacked by the hydrofluoric acid dip, so the acid fluoride baths must be substituted for it when parts of that metal are in the assembly.

Chrome-Sulphate Treatment

The cleaned parts are immersed in a bath at 150 to 160 F. for 10 to 20 min. for the chrome-sulphate process. The bath is composed of:

Magnesium sulphate	8.0 oz.
Potassium dichromate	5.3 oz.
Water, to make	1.0 gal.

A cold-water and a hot-water rinse follow. For small scale operations, the bath may be used at room temperature, increasing the time to 30 to 60 min. Glass or earthenware tanks may be used, or iron or aluminum containers, although in the latter case the work dare not be allowed to touch the metal of the tank.

Chrome-Alum Treatment

Treatment in a boiling chrome-alum bath for from 2 to 15 min. produces a smooth, adherent, compact film, brown to black in color. The bath consists of:

Chrome-potash alum	4.0 oz.
Sodium dichromate	13.3 oz.
Water, to make	1.0 gal.

Development of the black color indicates completion of the treatment.

Modified Alkali-Chromate Treatment

For the modified alkali-chromate treatment, the cleaned parts are held for 5 min. in a 15 to 20% solution of hydrofluoric acid, washed thoroughly, then placed in a boiling bath composed of:

Ammonium sulphate	4 oz.
Sodium dichromate	4 oz.
Ammonia, conc.	⅓ fl. oz.
Water, to make	1 gal.

After 45 min. in the bath the parts are removed, washed well in cold running water, and placed in a boiling solution of arsenous oxide, 1⅓ oz. per gal. The work is held here for 5 min. or more, then removed and washed with cold and hot water.

Borax Treatment

A 30-min. treatment in a boiling solution of borax and sodium bicarbonate will produce a light gray film on cleaned magnesium pieces, especially the magnesium-manganese and certain wrought alloys. Because of its light color, this film may be dyed to produce a decorative finish.

Caustic-Pressure Treatment

When painting cannot be applied to the treated work, the caustic-pressure process may be considered for the treatment. The pieces are subjected to a pressure of about 225 p.s.i. in an autoclave with a caustic soda solution of 13.3 oz. per gal., for 3 to 5 min. This film also is suitable for dyeing, and a dye bath may follow after thoroughly washing the caustic-treated work, or certain dyes may be used in the bath.

Prepared by Kenneth Rose, Engineering Editor

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METALS and ALLOYS
Engineering File Facts

NUMBER 68
January, 1945

Elastic Properties of Materials

Rigidity or stiffness is usually considered as one of the fundamental attributes of metals. For certain application, such as springs, we think of flexibility. The engineer realizes that both of these ideas are represented by the same property, modulus of elasticity.

The modulus of elasticity of a material is the ratio of unit stress due to an applied load, to the unit strain or deformation, within the elastic limit. It is expressed in pounds per sq. in. It is not dependent upon the tensile strength or yield point of the material, nor with the heat treatment or processing of the material. Beryllium copper is an exception to this rule, in that changes in heat treatment actually produce a change in modulus of elasticity. Temperature of operation also affects the modulus, rising temperature causing a decrease.

While the values given in Table II illustrate the effects of bending, the same proportionate relationships hold approximately true for these materials in torsion.

Table I

Modulus of Elasticity for Some Common Materials
(in millions of pounds per sq. in.)

	E	G
Aluminum alloys	10.3	——
Beryllium copper	16.0 to 18.5	6.0 to 7.0
Brass (70-30)	15.0	5.5
Cast iron	14.0 to 18.0	——
Chrome vanadium steel	30.0	11.5
Flat spring steel	30.0	11.5
Hard-drawn steel spring wire	29.0	11.5
High carbon steel wire	30.0	11.5
Hot-rolled steel bars	28.5	10.5
Inconel	31.0	11.0
K Monel	26.0	9.5
Magnesium alloys	6.5	——
Malleable iron	25.0	——
Monel	26.0	9.5
Music wire	30.0	11.5 to 12.0
Nickel silver	16.0	5.5
Oil-tempered steel wire	29.0	11.5
Phosphor bronze	15.0	6.25
Plastics	0.5 to 3.0	——
Stainless steel	28.0	10.0
Z nickel	30.0	11.0

In springs, the material must frequently undergo twisting. The modulus of elasticity in bending, which has been described, is usually represented by the symbol E, while the modulus of elasticity in shear, expressing stiffness in twisting, is expressed as G. These moduli are related by a definite value called Poisson's ration, having the value $\frac{E-2G}{2G}$.

As a guide to the deflections produced by a given weight in various materials, the following table has been constructed to show the deflection in inches that will be produced in a rod 1 in. in diam., 10 in. long, held at one end and supporting a 10-lb. weight at the other:

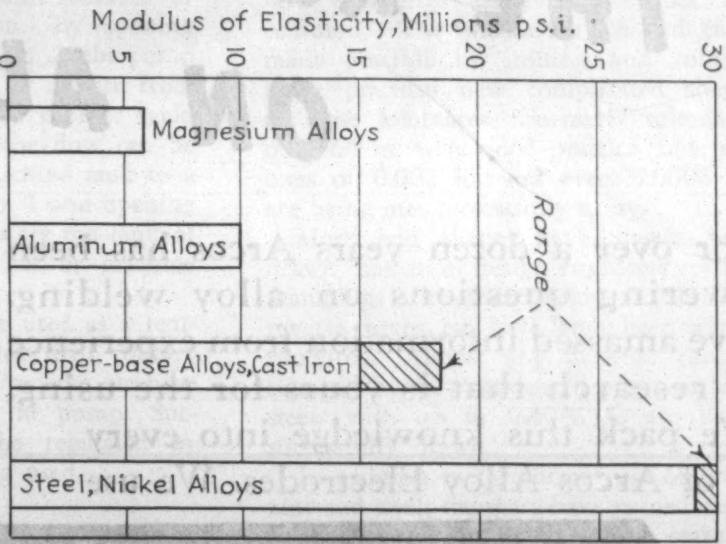
Table II

Material	Deflection	Load to Produce 0.001-in. Deflection
Aluminum alloys	0.0066 in.	1.5 lb.
Cast iron	0.0043 in.	2.4 lb.
Copper alloys	0.0043 in.	2.4 lb.
Magnesium alloys	0.0105 in.	0.95 lb.
Malleable iron	0.0027 in.	3.7 lb.
Steel	0.0023 in.	4.4 lb.

The following conditions or states of a given material are sometimes erroneously thought of as affecting its modulus of elasticity: (1) Hardness, (2) heat treatment or temper, (3) variations in alloy composition, and (4) method of production.

Except for very slight changes sometimes produced by variations in composition, and for the exception already noted in the case of beryllium copper, modulus of elasticity is independent of any changes in these properties. It is therefore impossible to attempt to reduce deflection under load for a given material by heat treating it. The only effect of hardening is to enable the material to carry a higher load without taking a permanent deformation. It does not affect its flexibility under loads below the elastic limit.

Modulus of elasticity for the common structural metals is shown in the accompanying bar graph. These values also represent the relative rigidity of the materials.



The modulus of elasticity finds a practical use in calculating sizes when substituting one material for another in a spring. The formula expressing these size relationships is:

$$t_1 = t_2 \sqrt[3]{\frac{E_2}{E_1}}$$

where t_1 and E_1 are the thickness and modulus of elasticity, respectively, of the new material, and t_2 and E_2 are the values for the material being replaced. Values of G are not given, as changing materials in a helical spring usually requires a more complete redesign of the part.

Prepared by Kenneth Rose.
Based in part upon a Materials Laboratory letter of Sperry Gyroscope Co., Inc.

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WELDING
STAINLESS STEELS
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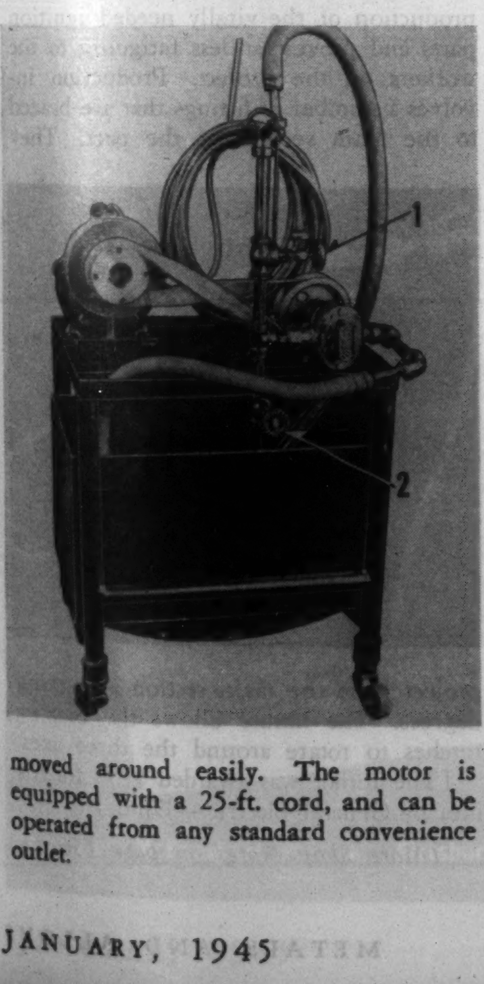
Tulsa, Oklahoma	Hart Industrial Co.
Wichita, Kansas	Watkins, Inc.

engineering SHOP NOTES

Portable Oil and Coolant Pump

by H. Small,
Westinghouse Electric & Mfg. Co.

Here are a motorized pump and tank that proved to be useful in departmental or general maintenance for servicing machines that use oils and coolants. It can be put together in most any shop. This setup is light, powerful and compact, and is mounted on castors so that it can be moved around easily. The motor is equipped with a 25-ft. cord, and can be operated from any standard convenience outlet.



Variations in the application of this assembly are made possible because of the 3-way piping system. By opening valve No. 1 and closing No. 2, the pump can be made to move oil or coolant from a container to a machine coolant tank. By reversing the hoses, the flow can be made to go from the machine tank to a container. By closing No. 1 and opening No. 2, the pump will empty the tank of this setup into a container or machine tank.

The equipment can be used as a temporary coolant system for drill presses, etc. by having a return from the machine table to the tank under the pump. Suction or pressure can be regulated by adjusting the valve being used.

Modern Accomplishments with Stamping

by Carter C. Higgins,
Worcester Pressed Steel Co.

Perhaps not all design engineers have kept up-to-date on possibilities of stampings. Every design or production engineer should now consider stampings for new products, individual items, sub-assemblies and complete assemblies. Although stamping is essentially a mass production technique, recently-developed methods of tooling have made runs of even 1000 pieces practical.

We used to think of stampings in connection with light, uniform sections; now stampings using ½-in. stock are common. The variations in thickness made possible by ironing and coining make practical new complicated shapes to close tolerances. Formerly tolerances of 1/64 in. were good practice, but now ones of 0.002 in. and even 0.0005 in. are being met successfully today.

More odd shapes have always been drawn than most design engineers realize. Stampings with sharp folds, small radii, reverse curves, etc. have lately been widely produced. Almost any material can be stamped by an experienced engineer, and steels with up to 0.40% C are being successfully drawn.

In addition to the former use of brass, zinc and steel, stampers have gained much knowledge of aluminum alloys, stainless steels, with some working with magnesium.

To simplify the cutting out of complicated designs from sheet metal stock up to 7/64-in. thick with a portable power hand shear at the Fitchburg plant, General Electric Co., we designed and built a swinging arm holding fixture that supports the shear. This makes it much easier to operate the shear, and gives better control of the work when cutting complicated designs.

—**E. A. Forss, General Electric Co.**

Filling Holes and Cracks in Castings

by A. F. Davis,
Lincoln Electric Co.

A successful method for repairing surface holes in machined castings at Kearney & Trecker, Milwaukee, is by filling them with "Softweld," a non-ferrous electrode, made expressly for producing machineable welds in cast iron. The weld metal is applied in two passes and then machined, with no more than a half stick of electrode per hole required.

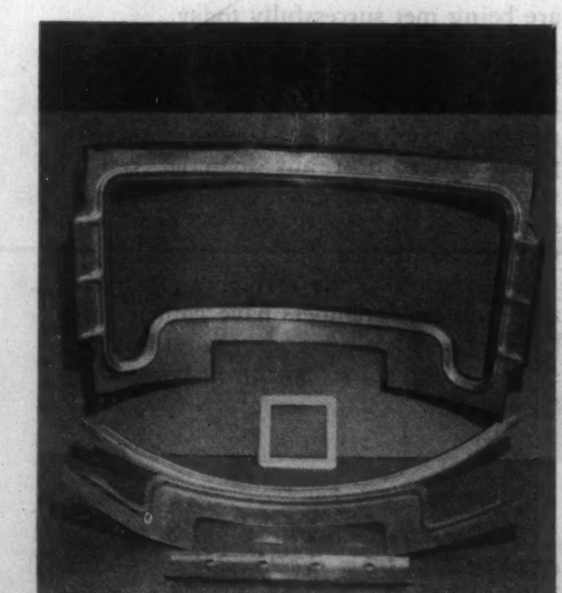
At the Kearney & Trecker plant, practically all castings have six or more holes after being machined. Accumulative straining in the parent metal is avoided by heating with an acetylene torch prior to arc welding with ⅛ or 5/32 in. electrodes.

Where shrinkage cracks occur in the casting, it is ground to shape, this not marring its appearance. In repairing the cracks, "Ferroweld," an electrode for producing welds in cast iron with tensile strength equal to the cast iron itself, is usually used.

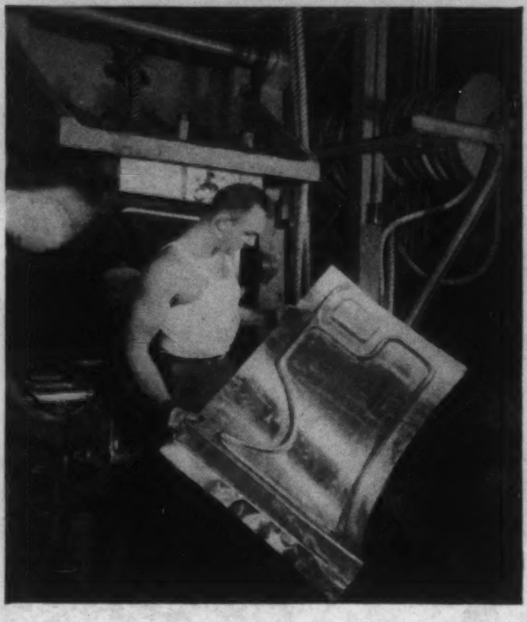
Evolution of Cowl Fabrication

by Mason L. Arnold,
Lockheed Aircraft Corp.

This is the story of an interesting bit of cooperation between the designer and the man in the shop that saved thousands of dollars and man hours. A "doubler" is a section of airplane cowling. Originally, this doubler for the PV, Navy land-based patrol bomber, was fabricated from nine different parts. Now new hydropress dies blank and form the parts in one piece without the previous assembling. Much spot welding and riveting has been eliminated and 112 man hours per airplane have been saved.



Total savings over the life of the contract are $202 per airplane. One hundred and fourteen fewer men are needed per operation on cowling, and only 16 routing cards are used where 116 were previously needed. The number of parts per airplane has been cut down from 178 to 20. Tooling cost has been reduced from $60,000 to $12,400; tool repair cost from $23,000 to $4,000. Spotwelding has been reduced from 12,610 hr. to 5,540 hr.; riveting, from 62,400 hr. to nil.



Other reductions have been in time required for stock room handling, transportation of parts, shearing, hand forming, burring, sawing, drop hammer work, sheet metal sub-assembly (to nil).

In the accompanying first photograph, the nine original parts appear in the bottom half, while in the upper half is the new doubler, formed in one piece. The metal cut from the center of the doubler is used for fabricating other parts. The second photo shows the finished form at a stage when speed hammering, layout, trimming and burring was necessary. But this has been replaced by hydropress dies.

Continued refinement has been taking place. At first the finished form required speed hammer, etc. Then new hydropress dies to replace drop hammer dies for blanking and forming were used. At first, spotwelding of the doubler and skin on the cowl panel was done with the aid of "Clecos" (clamps). A new fixture was then designed to shorten assembly time.

Adding of serial numbers has been shortened, since there is only one part to be numbered instead of nine. The hydropress has eliminated pin routing, hand burring of detail parts, punch press work on small parts, layout, scribing, drilling and trimming.

(The author of this sketch was awarded a check for $3000 by Lockheed, for his idea and advice.—Editor)

Welding rods in a California plant were formerly used while green, causing them to sputter. Welders used only part of each rod, throwing the balance away when sputtering started. Now the reserve stock of rods is kept in a room with a uniform heating system with thorough circulation. The boxes are opened so that the rods dry throughout. A saving of at least 40% has resulted.

—**Benjamin Rothenberg,**
Concrete Ship Constructors

Formula for Metal Polish

by F. W. Smither,
National Bureau of Standards

In the formulation of metal polishes and cleaners, soap serves as a cleansing, a "wetting" and an emulsifying and stabilizing agent. Here is the formula for a typical paste polish: Chip soap, 10 parts; silica dust, 20 parts; air-floated tripoli, 20 parts; pine oil, 2 parts; water, 48 parts.

Dissolve the soap in the hot water and add the previously mixed silica and tripoli without stirring; then add pine oil, with stirring, and run the hot mixture into suitable containers. The abrasives, silica and tripoli, should be able, almost 100%, to pass through a No. 325 sieve.

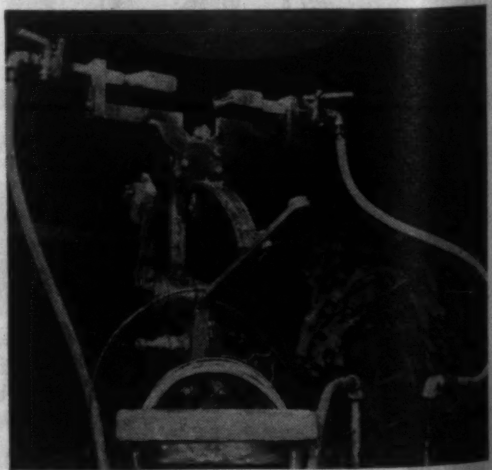
Diaphragms for sensitive pressure gages are now made by seam welding instead of crimping and soldering the edges. Formerly of beryllium-copper or phosphor-bronze, they are now of stainless steel and Monel, from 0.006 to 0.008 in. thick. Before, two separate stampings were made, allowing an extra flange on one stamping for crimping. Now, two sections of the same stamping are seam-welded together. This makes a better diaphragm at less cost.

Brazing Fixture for Three Axes

by J. G. Gomperts,
General Electric Co.

Considerable time was saved in brazing ignition parts for aircraft after a "Rube Goldberg" brazing fixture was developed, a fixture that can be rotated around three different axes. Previously, it had been planned to relocate the main section of the ignition parts.

The new fixture not only improves the accuracy of the work, but also increases production of the vitally needed ignition parts and proves far less fatiguing to the workers on the project. Production involves a number of fittings that are brazed to the main section of the part. They project from the main section at varying degrees. The fixture allows the brazing torches to rotate around the three axes.



[The author was awarded $750 for his idea by General Electric.—Editor]

(More Shop Notes on page 156)

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Fork Truck for Annealing Oven

by Ben Gapinski,
Milwaukee Malleable & Grey Iron Works

It formerly required a full day for a complete cycle of loading and unloading an annealing oven at the Milwaukee Malleable & Grey Iron Foundry Co., using a steam-powered oven charger. Today the cycle has been cut to just half that time by using a standard fork truck of 4000-lb. capacity.

The annealing pots have to be stacked four deep, six abreast, across the oven from end to end. Formerly, the work was done by a steam-powered, steel-wheeled, rear-end control ovencharger. The operator must arrive two hours in advance of charging to fire up and get up steam.

Loss of steam and low truck speed proved inefficient. The rear-end control compelled the driver to remain in the end of the oven, picking up the last two rows of pots for 10 to 15 sec. in 600 F. heat on each trip.

The fork truck that replaced the old equipment is gasoline-powered, with low overall height and controlled by the operator in the center of the machine directly behind the load. The operator is protected from direct heat from the pots by a sheet steel shield mounted behind the forks. The low height permits operation against the oven side walls. The driver's position near the load gives quicker and more positive control of operations. The vehicle's speed means minimum time inside the oven.

By use of a shovel attachment and an additional pair of forks, the truck can handle new and spent sand, core boxes, molds and other items.

Cemented Carbide-Diamond Dressers

by John Curtis,
Carboloy Co., Inc.

Wheel dressers made with small commercial diamonds set into a matrix of Carboloy cemented carbide have saved considerable time and money at one of Detroit's largest aircraft engine plants, where they are being used to true-up recesses in finish grinding wheels employed to grind the outside diameter on aircraft cylinder sleeves.

When a conventional single diamond dresser was used for the recessing, which is necessary so that the wheel may produce a sharp corner at the bottom of the cylinder sleeve's flange, the holder had to be ground flat and the diamond lapped so the stone would perform the dishing-out operation correctly without the holder touching the edges of the recess when swinging it through an arc.

The Carboloy diamond-impregnated dresser, on the other hand, contains diamond particles distributed throughout the matrix, thereby insuring that at least one or more of the stones will be in contact with the grinding wheel at all times as the holder is swung through a small arc. Moreover, new cutting faces are presented to the abrasive wheel as layer after layer of diamonds are reached and exposed, due to the gradual wearing-away of the carbide matrix. Hence, no lapping and no re-mounting are needed.

Reports from the former automotive manufacturer's grinding department also indicate that these dressers lower the cost per wheel dressing on the average job and successfully stand abuse that would ruin a single diamond dresser.

Tool steel tubing is now being used for bearings, heavy-duty bushings, sleeves and other machine tool parts. An instance where it replaced bronze bushings is a Giddings and Lewis table-type milling machine headstock incorporating main spindle sleeve bushings. For a close fit between spindle and sleeve, two bushings are inserted, their internal bore being ground after insertion in the sleeve. Tool steel was used to prevent excessive wear and for permanent close fit. It has been most successful, and has eliminated galling and scoring. It was possible to use straight bushings and eliminate a take-up device needed by tapered bronze bushings.

—Ralph Maitland, Cleveland

Peening Square Rivets Automatically

by Frank Navarra,
Fairchild Camera & Instrument Corp.

It formerly took 25 min. by hand labor to peen square rivets into small steel cams to fasten a cam to an aerial camera camshaft, which is the heart of the between-the-lens type camera shutter. A new automatic method of peening has reduced this time to 2 min. Standard riveting machines provide a rotating hammer that peens only round rivets. The rotating motion prohibits riveting small diameter surfaces. Furthermore, round rivets are too big for some surfaces because they spread too much.

Moreover, Fairchild had a surface obstructed by other parts, limiting the peening clearance to less than the width of a square rivet. Since the camera shutter opens and closes its leaves at 1/800 sec., much care is given its precision machining. Until recently, highly skilled employees, with special tools, hand-riveted the camshafts.

By removing the pulley on the riveting hammer and fastening a horizontal shaft to hold it in place, the hammer cannot swing or turn, but has the desired up and down motion which eliminates the serious hindrance of the hammer's rotation and allows for peening square rivets on extremely small surfaces.

Allied with this is a new holding fixture in two sections, a base and an adapter. The base is standard for all jobs, whereas individual adapters can be provided for separate jobs. The base is screwed onto the table of the riveting machine. A center sliding part, controlled by a handle, moves forward and back, adjusting the position of the part to be riveted, so that it conforms to the width of the square rivet.

The interchangeable adapter, or top part, can be revolved 90 deg. and has a spring clamp to hold the part down during riveting. The hammer conforms to the desired shape of the square rivet. When one side of the riveting is done, the fixture is lifted and turned 90 deg. for the concluding operation.

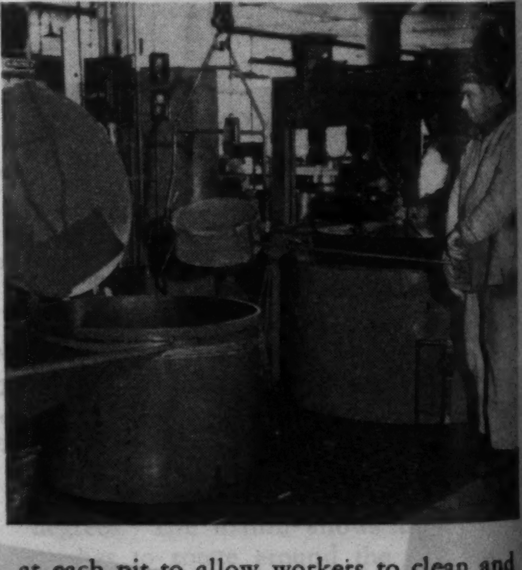
Grant riveting machines are used, but special holding fixtures could be applied on any standard machine.

Steel Grating Over Furnace Pits

by A. L. Greene,
Irving Subway Grating Co.

Steel grating over the pits in which small carburizing and annealing furnaces are set offer several advantages. It provides ventilation for the furnaces, sure footing for workers, and does not gather oil, water and other foreign matter as would solid flooring.

The United-Carr Fastener Corp., Cambridge, Mass., depicted here, has five furnaces around which it has used 1¼-in. grating. A trap door has been installed at each pit to allow workers to clean and make adjustments. The grating bridges the gap from the side walls of the furnaces to the edges of the pits.



Metal-Working Industries

Edited by Kenneth Rose

Engineering Editor,
Metals and Alloys

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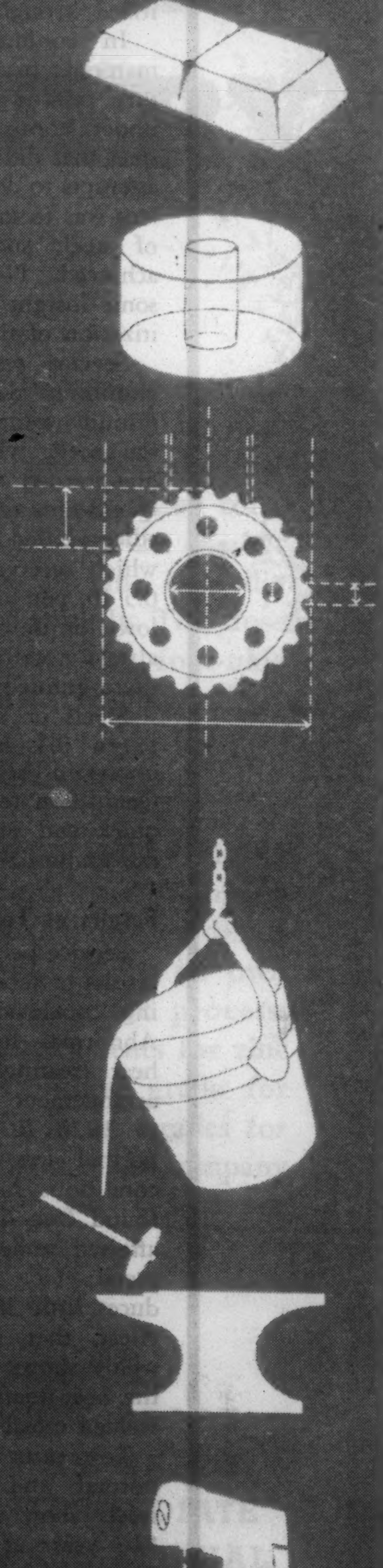

ENGINEERING DIGEST

A selection of outstanding articles on
engineering materials and processing methods

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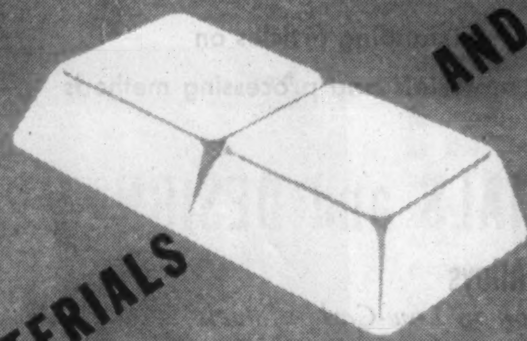

METALS and ALLOYS

Engineering properties and applications of carbon, alloy and stainless steels, irons and nonferrous metals and alloys. Selection and evaluation of metallic materials for engineering service. New alloys and modifications.

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Graphitization in Low-Carbon Steels

Condensed from a Paper of the American Society of Mechanical Engineers

Considerable information is available on graphitization of high carbon steels, but there are only a few cases of graphitization in low carbon steels, and no case of graphite formation in low carbon-molybdenum steels until after the failure of steam pipe at the West Penn Power Co.

Steels that displayed in the McQuaid-Ehn test a normal case with a grain size of 1 to 5 did not graphitize in service. Steels that were abnormal and fine-grained (7 to 8) did graphitize, though in the case of castings some have and some have not. The degree of graphitization among graphitized wrought steels varied.

In conjunction with investigation of materials from service installations, laboratory tests were carried out to graphitize under controlled conditions the type of steel that did not graphitize in service. All attempts to do this failed. The second problem was to graphitize the intermediate type of steel, and in this some success was achieved. Finally, it was desired to gain some insight into the mechanism of graphitization of these low-carbon steels.

Service results showed that the high-aluminum deoxidized materials, with aluminum additions of over 1.5 lb. per ton melt, which were found to be very fine-grained and totally abnormal in McQuaid-Ehn test, were graphitized. Straight silicon-killed steel or castings, and those which received aluminum additions below 0.5 lb. per ton, failed to graphitize. These low-aluminum deoxidized materials were always totally normal and coarse to medium-grained in the McQuaid-Ehn test.

Steels or castings that had received between 0.5 and 1.0 lb. per ton were of uncertain behavior. In general, the McQuaid-Ehn test appeared to be a relatively quick and sufficiently reliable indicator of the graphitizing tendency of a steel.

Results of Tests

Service behavior of the materials and the results of laboratory tests led to the following conclusions: Low carbon steel: (1) Abnormal low-carbon steel with normal heat treatments graphitizes in a random arrangement in the observed range of 850 to 1020 F. with reasonable stress; (2) normal low-carbon steel under identical conditions for 8¾ years at 1020 F. was found free of graphite in both the weld-affected zone and in the weld-unaffected metal; (3) welding abnormal steel produces little if any localized or preferential effect, that is, the heat-affected zone of welds shows no more graphitization than the heat-unaffected metal; (4) carbon steel welded metal has graphitized in some cases.

Low carbon-molybdenum steel: (1) abnormal and normal carbon-molybdenum steels show slight, if any, graphite after 5½ years at 935 to 950 F., and shorter periods, 4 years at 1050 F., except in such cases where abnormal steel has been subject to heating and cooling either by welding or other heat application through lower critical range; (2) molybdenum exerts a very definite resistance to graphitization; (3) abnormal carbon-molybdenum steels in general, when subjected to heating and

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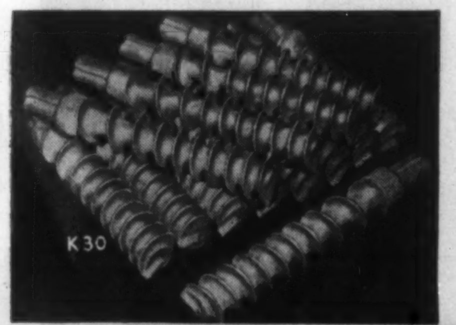
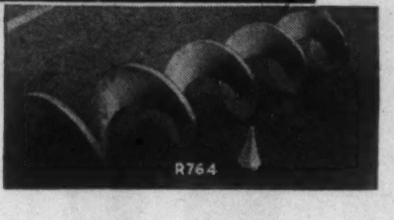
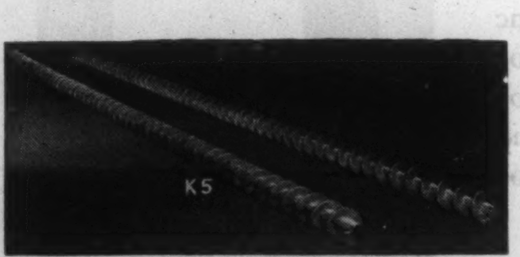
Amsco Alloy also performs well and economically when used for furnace conveyor chain, trays, containers, furnace fixtures, burner nozzles, hearth plates and other high temperature applications.

Send for Bulletin 108.





K-30 Chemical extrusion screws of F-3-N, a high chromium low nickel alloy. Resistance to corrosion is even more a consideration than heat resistance in this case. R-764 Amsco Alloy Grade F-10 hot material conveyor flight or screw and guide, before welding to alloy central pipe. This easy-to-machine, medium-strength alloy has only slightly less load carrying strength at temperatures up to 2000° F, than more expensive alloys.



K-5 Amsco Alloy F-10 conveyor screws for rolling round copper billets through a heating furnace after which they are extruded into copper tubes.

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cooling operations, graphitize in service at temperatures as low as 915 F.

(4) Repeated applications of the heating and cooling cycle promote graphite formation in a given time at the subcritical temperature of 1000 F.; (5) increased rates of heating and cooling appear to favor formation of chain graphite; (6) slightly abnormal carbon-molybdenum steel that has been subject to the heating and cooling cycle has shown slight graphitization in service at 950 to 975 F.; (7) normal carbon-molybdenum steel that has been subject to the heating cycle is not graphitized in service at temperatures up to 975 to 990 F., in the same pipe line in which abnormal carbon-molybdenum steel has graphitized severely.

(8) Normal carbon-molybdenum steel subjected to repeated heating cycles in the laboratory has not developed graphite after 6000 hr. at 1000 F.; (9) carbon-molybdenum weld metal, although abnormal in a McQuaid-Ehn test, has been found free of graphite; (10) McQuaid-Ehn test has proven to be a valuable criterion of the graphitizing tendency of carbon and carbon-molybdenum steel.

On the basis of studies made, it was recommended that coarse-grained normal carbon-molybdenum steel with an addition of 0.4 to 0.6% Cr be used for high-temperature steam plant applications because of the greater stability of the carbide phase in these normal steels as compared to similar steels showing abnormality on the McQuaid-Ehn test.

—H. J. Kerr & F. Eberle. Paper, *Am. Soc. Mech. Engineers*, Nov. 1944 meeting, 42 pp.

Lighter Weapons from Magnesium

Condensed from "Army Ordnance"

Magnesium alloy castings have practically the same mechanical properties as aluminum alloy castings and are one-third lighter in weight. The higher endurance limit and the considerably greater spread between the yield and tensile strengths of the magnesium alloy, together with its lower modulus of elasticity, indicate its superiority over the corresponding aluminum alloy for applications subjected to shock loads.

Used as a 60-mm. mortar base plate, the magnesium alloy will withstand as much rough service as the present standard steel base made of welded plate. These cast magnesium bases will be competitive, costwise, with the welded steel bases. As an artillery carriage wheel, the magnesium alloy wheel weighs 19 lbs. as against 32 lbs. for the steel wheel. It has withstood all rigid service tests required of artillery wheels.

In tests, unprotected magnesium alloys are practically as good as the unprotected aluminum alloys in all exposures, including sea water, and several times superior to unprotected structural steel. As to magnesium's ability to withstand fire, gasoline tanks of the Spitfire airplane are made of magnesium alloys.

Wrought magnesium alloys can be heli-arc-welded with a loss in strength at the

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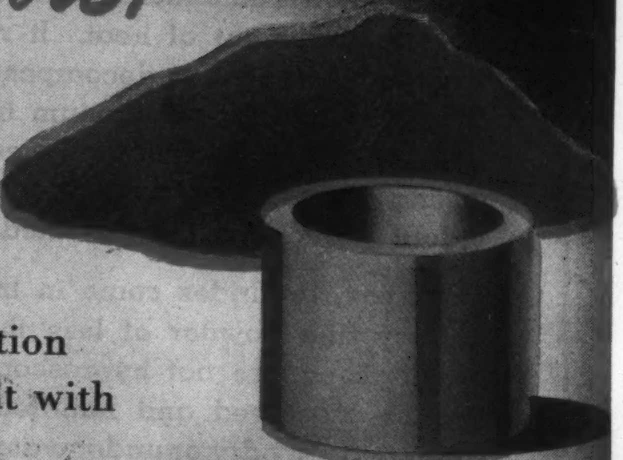

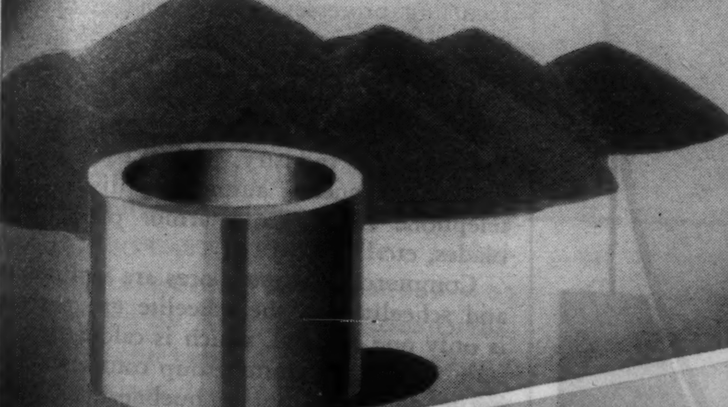

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weld of only 10 to 20% of the parent material as against 40% for arc- or flame-welded aluminum. Magnesium alloys can be extruded into complicated shapes, thus permitting the design of shapes having a cross section wherein the material is distributed most efficiently to give a maximum stiffness-weight or strength-weight ratio.

The shear strength is usually 20% lower than for aluminum. Magnesium alloys have a relatively high fatigue strength, but they are notch sensitive. Good fatigue strength and damping capacity permit heavily impact-stressed parts.

There is generally no danger of stress corrosion cracking in castings, extrusions, rod, tubing, or forgings, because these products are made at elevated temperatures. They are not adversely affected at temperatures as low as minus 108 F.

—C. H. Corey. *Army Ordnance,* Vol. 27, Nov.-Dec. 1944, pp. 457-460.

Tungsten

Condensed from "Mill and Factory"

The biggest advance in the use of tungsten took place during the past 20 years. In World War II tungsten carbide tools and dies are performing a vital part in turning out equipment and weapons. The amount of tungsten alloyed with steel in commercial tool steels may vary from 1% to 18%, or even higher, and carbon content may be from 0.30 to 1.30%. Practically all these steels contain chromium from 0.50 to 5%.

A non-ferrous alloy, called Stellite, is a cobalt-chromium-tungsten product, which is said to exceed high-speed steels in hardness at temperatures above 1100 F. It is resistant to corrosion and wear.

Tungsten-molybdenum alloys are used mostly where temperature is high and where a more ductile product than tungsten is necessary. Copper- and silver-tungsten alloys have various electrical applications.

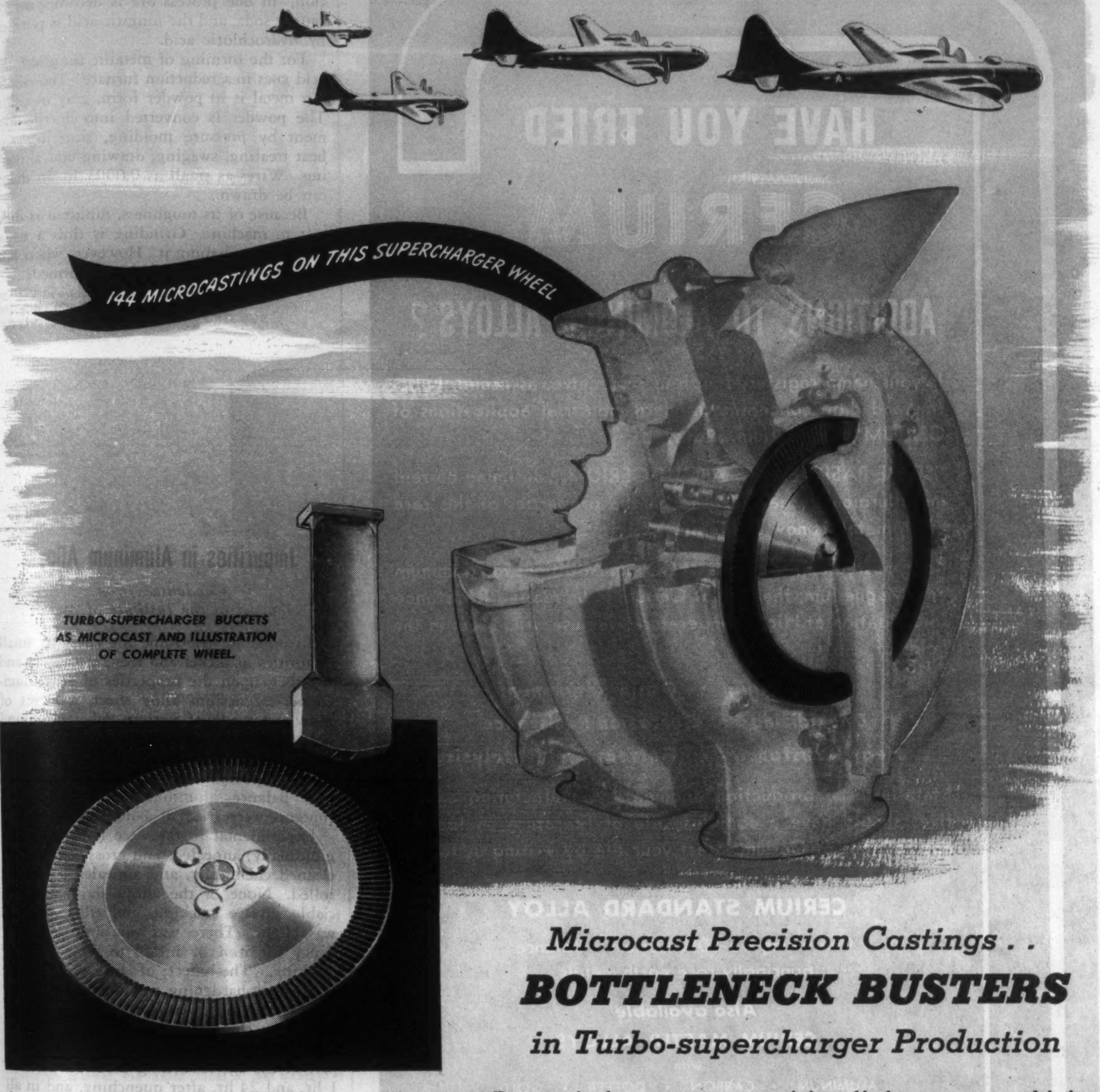
Tungsten carbides are used in the manufacturing processes as tools and cutters for turning, forming, drilling, broaching, etc. They are also used for arbors and mandrels, slitting saws, masonry and rock drills.

Largest adopter of metallic tungsten is the electrical industry. Other uses include airplane magnetos, automotive distributors, telephone call systems, armor plate, razor blades, etc.

Commercial tungsten ores are wolframite and scheelite. In the scheelite group there is only one mineral, which is calcium tungstate. The wolframite group comprises ferberite, an iron tungstate, huebnerite, a manganese tungstate, and wolframite, an iron-manganese tungstate.

Tungsten ores, especially low grade and those with many impurities, are often converted to concentrates. The highest grade of concentrates may run 70% tungsten trioxide. In domestic grades, tungsten oxide may be 60 to 65%.

Tungsten ores and concentrates are treated for the production of ferrotungsten, sodium tungstate, tungstic acid or metallic tungsten. Most of the ores go into making ferro-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tungsten, which is used in producing tungsten steel.

There are various methods of ore reduction. In one process ore is decomposed by caustic soda, and the tungstic acid is purified by hydrochloric acid.

For the forming of metallic tungsten, the acid goes to a reduction furnace. The resulting metal is in powder form, gray in color. The powder is converted into ductile filament by pressure molding, sintering and heat treating, swaging, drawing and annealing. Wires as small as 0.0003 in. in diam. can be drawn.

Because of its toughness, tungsten is difficult to machine. Grinding is thus a usual method for shaping it. However, when hot, tungsten can be blanked and formed.

—E. J. Clement. *Mill & Factory,* Vol. 35, Nov. 1944, pp. 120-121, 278, 282, 286, 290, 292, 296.

Impurities in Aluminum Alloys

Condensed from
"Journal of the Institute of Metals"

In order to determine the effect of small quantities of nickel and iron, separately and together, upon the properties of aluminum-copper-magnesium alloy sheet, a series of tests was made of various fabricating and heat treating procedures with controlled alloy compositions. The alloy had a nominal composition of 4% Cu and 0.60% Mg, balance aluminum. Iron-plus-nickel contents were tried to a maximum of 1%.

Experimental ingots were hot-rolled longitudinally, annealed, and cross-rolled, then cleaned chemically, and annealed and cold-rolled. None of the alloys showed appreciable surface cracking, and edge cracking was slight. There was no noticeable tendency for iron or nickel to increase edge cracking. The effect of iron and nickel upon work-hardening was unappreciable.

Iron and nickel showed no effect upon annealing characteristics, but the effect on age-hardening was marked. The greater part of the age-hardening occurred between 1 hr. and 24 hr. after quenching, and in all the alloys the period of rapid age-hardening was followed by one of slow hardening, continuing to a slight degree over the full three-month period of test.

Both the rate and extent of age-hardening were reduced progressively with increasing content of either nickel or iron, and when both are present, the effect is approximately additive to 1%.

Tensile strength was progressively lowered by iron or nickel, with iron having the greater effect. A total iron-plus-nickel content of 0.75% caused the proof stress value to fall below specification requirements. The effect upon ductility was, for all practical purposes, negligible.

Examination of the microstructure of the alloys was carried out to determine the extent to which intermetallic compounds remained unabsorbed after heat treatment.

(Continued on page 172)

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The shape and distribution has an important effect upon the bending qualities of the material.

It was found that unabsorbed material was roughly proportional to the total iron-plus-nickel content. However, with increase of unabsorbed material there was a general refinement of particle size, so that relatively small deterioration of bending quality occurred.

Corrosion resistance was tested in the conventional salt spray apparatus, and by an accelerated test using sodiumchloride-hydrogen peroxide. Results showed that both iron and nickel in the higher proportions produced some slight increase in corrodibility, but that the change, in comparison with variations between alloys of different types, was of no practical importance.

—Maurice Cook & R. Chadwick. *J. Inst. Metals*, Vol. 70, Sept. 1944, pp. 423-433.

Alloy Steels for Nitriding

Condensed from "Archiv Eisenhüttenwesen"

Steels with 0.24 to 0.38 C, 0.28 to 1.18 Si, 0.70 to 2.65 Mn, 0 to 1.22 Al, 0 to 0.35 B, 0 to 2.43 Cr, 0 to 0.61 Mo, 0 to 0.97 Nb-Ta, 0 to 1.42 Th, 0 to 0.23 Ti, 0 to 0.26 V and 0 to 0.56% Zr were investigated in tough-hardened condition for their adaptability for nitriding. Higher additions of such elements that form very stable special carbides impair reduction of area and, in particular, notch-impact toughness. This effect can be ascribed to the presence of the presumably brittle special carbides.

It seems, furthermore, that these special carbides produce a kind of germination with regard to the process leading to temper brittleness, so that tempering of even short duration leads, in spite of subsequent quenching, to an embrittlement which does not become essentially stronger by long-time tempering.

A definite relation was established between notch-impact toughness of the core material and the characteristic properties of nitrided specimens obtained in static bending tests. The aluminum alloy steels have to have a lower notch-impact toughness at lower overloads of the nitrided layer than aluminum-free steels in order to exclude a deformationless fracture if cracking occurs in the nitrided layer due to overload.

With regard to nitriding hardness and depth, an alloy steel with higher than 650 Vickers hardness, of 0.25 to 0.35 C, 0.75 to 0.9 Si, 1.7 to 1.8 Mn, 0.75 to 0.9 Cr and about 0.25% V, was found satisfactory for some purposes. The tendency to hot-embrittlement of this steel, which increases with higher manganese content, can eventually be reduced by a small molybdenum addition. Strong special carbide-forming additions do not increase the nitriding hardness of this steel and of similarly composed chromium-free steels.

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Specifications . . . Army-Navy Aeronautical Spec. AN-A-17; U. S. Navy Spec. 46A-1 (INT), Class 1; A. S. T. M. Spec. ZG-41, alloy O.

Typical Physical Properties . . . tensile strength, 35,000 psi.; yield strength, 25,000 psi.; elongation, 5% in 2".

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For nitriding hardnesses above 950 Vickers, the following molybdenum-free steel seems suitable: 0.32 to 0.38 C, 0.3 Si, 1.4 to 1.6 Mn, 0.6 to 0.7 Al, 0.65 to 0.75 Cr and 0.25% V. In spite of hot-embrittlement, molybdenum addition is here unnecessary as the nitrided steel has no tendency, even at low notch-impact toughness, to deformationless fracture if the nitrided layer cracks due to overload.

—H. Cornelius. *Arch. Eisenhüttenw.*, Vol. 17, Aug. 1943, pp. 77-88.

Properties of Case-Hardened Materials

Condensed from "Canadian Metals & Metallurgical Industries"

In ordnance work, case hardening is used not only to resist wear but also to withstand severe bending and impact in service. The failures in cased parts were found to be due to inability of the case to resist bending without cracking, brittleness of the cased part, or sub-surface fatigue failure.

The fatigue failures occur in the transition zone; therefore, the fatigue life can be increased by increasing the hardness of this zone, but this means is limited by brittleness of the part. Commercial carburizing was found to give erratic results, and new acceptance tests were needed to ensure that poor material would not go into service.

Specimens, 10¼ in. long by 7/16 in. round (approximately the size of the ordnance part), were heat treated with the carburized parts and then subjected to bending and drop impact tests. These two tests were found to give results very closely related to service behavior in the field, even though many of the latter failures were of the fatigue type. In the bend test, the specimen was freely supported on 8-in. centers and bent with a 12-in. radius bending block applied manually at a normal rate.

The number of inches deflection when the first audible crack in the case was heard was taken as the case break point. This end point was clear and unmistakable. The drop-impact test was a go no-go test where the sample was freely supported on 8-in. centers and subjected to a 45 ft.-lb. blow. If no failure took place, the specimen was considered satisfactory.

Experience with these tests led to the establishment of the following specification for optimum values for SAE 3115: Minimum surface hardness, Ra 80; core hardness Rc 24-32; case depth, 0.012 to 0.020 in.; bend deflection at the case break point, 0.25 in. minimum; impact 45 ft.-lb. blow must be withstood.

If NE 8620 were substituted for SAE 3115, the core hardness would have to be increased to Rc 37-44 and the case depth decreased to 0.010 to 0.014 in. The NE 8620 would then give satisfactory results in the bending and impact tests, but somewhat shorter service life would be expected due to the thinner case.

—S. L. Gertsman & I. H. MacPherson, *Canadian Metals & Met. Inds.*, Vol. 7, Oct. 1944, pp. 32-33.

A Happy Solution

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An excellent example of design and engineering teamwork in action is the combination shown—clear molded plastic container with a high pressure die cast aluminum cap.

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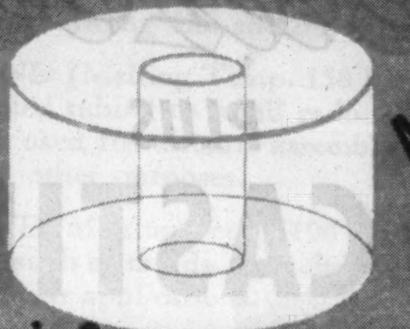

MATERIALS AND DESIGN

NONMETALLIC MATERIALS

Design-uses of plastics, plywood, fibre, glass, rubber, ceramics, etc. as engineering materials. Composite metal-nonmetal combinations. New types and forms of nonmetallic materials.

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Resin Impregnated Plywood

Condensed from "Modern Plastics"

In order to improve plywood for war materials packaging, a line of phenolic impregnated papers has been developed for application to the base plywood. A tough, waterproof skin is formed, giving the material many of the properties of a thermosetting laminate, with the high strength and low cost of the plywood. Transverse strength is improved.

The surface is hard, abrasion-resistant, has extremely low moisture absorption and water-vapor permeability, and is applied as a film about 0.009 in. thick, weighing about 60 lb. per thousand sq. ft. of area. Resin impregnation is done in the papermaking process, and techniques have been worked out to make it possible to cure the thin laminate and bond it to the outer surface of the plywood in a single operation in the plywood manufacturer's plant. Economies obtainable by this process bring the price of the material within the reach of mass markets.

Colors are limited to olive drab and black to meet military needs at present, but research already well advanced assures a wide range of colors for peacetime markets. The finish may be glossy, satin, or matte.

While stable for interior use, it shows slight fading upon prolonged exposure to the weather when phenolic resins are used for the surfacing. The surface shows excellent chemical stability to weak acids and alkalies.

Douglas fir plywood has been used as an inexpensive structural material for years, but has been limited in its adoption for many purposes by its pronounced tendency to surface checking and grain raising. The present surfacing minimizes this tendency, and developments already in process seem to promise grades that will bridge blemishes and gaps in the wood. This would permit upgrading of veneers that have been classified as below standard upon an appearance basis only.

While the material in its present form must be cured under the action of heat and pressure, development of a precured type of plastic surfacing in roll form may become a reality in the future.

—Modern Plastics, Vol. 22, Nov. 1944, pp. 118, 212.

Post-War Road Transport

Condensed from "Light Metals"

The use of light metal alloys in construction of commercial trucks in Europe is more advanced than in the United States. For six or seven years such trucks have been common in Germany, France, Switzerland and Great Britain.

Chief incentive for lightness is highway taxes. Thus, in Britain the dividing line is 2½ tons, unladen. Under that, taxes are lighter and the truck is permitted to run 30 miles per hr.; heavier, taxes are higher, with speed limit of 20 miles per hr.

HOW TO GET THE MOST OUT OF PLASTICS

In solving a material problem, substantial benefits frequently occur which are in addition to those originally anticipated. Such was the case with the Warren Lamp Company, producers of the glass-bodied plug fuses illustrated above.

The problem which this company's research department set out to solve was to lighten the over-all weight of the plug fuse without sacrificing its quality. The reason for this attempt to lighten their product is obvious when you realize that it is the policy in the electrical manufacturing trade to prepay freight charges on all shipments up to 100 pounds.

As no other transparent material has the inertness of hard glass and as there is no satisfactory substitute for brass, the only part of the fuse that could be altered was the tip.

In the past it had been customary to use another type of mineral-filled material for this fuse tip. However, after extensive experimentation, it was found that by changing to a cellulose-filled Durez molding compound a substantial saving in weight resulted. This was because cross-sectional areas could be made much thinner due to the fact that the part molded from Durez was ten times as strong as the material previously used.

In addition to this weight-saving feature, reductions in production costs and time were achieved through a specially designed molding process, which substantially reduced the molding cycle.

Another example of the effectiveness of co-operative effort between the design engineer custom molder and plastics producer

The versatility of the more than 300 Durez phenolic molding compounds in conjunction with the vast experience of Durez technicians make Durez' services extremely valuable to the design engineer with imaginative ideas. You can count on the complete cooperation of the Durez staff at all times in helping you and your custom molder work out any materials problem which you may have. Durez Plastics & Chemicals, Inc., 271 Walck Road, N. Tonawanda, N.Y.

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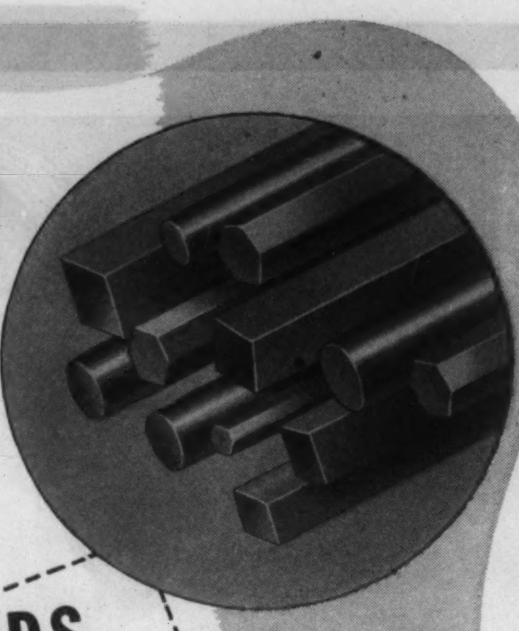

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A certain British truck, built largely of light metals, weighs just 2½ tons, but would weigh in at 4 tons if constructed of the same size and design and of conventional materials. Besides, a light metal truck often means smaller working parts, smaller tires, more miles per gallon and less costly upkeep.

British designs and techniques are described here. With a few exceptions, no striking development in the use of light alloys in the chassis has yet been seen, though opportunities are considerable. Below the springs, use of forged light metal wheel discs and rims and front and rear axles will help road-holding properties and reduce shock load, meaning lighter tires and lighter springs.

Above the springs the use of light alloy castings for crankcase, clutch and gear housings is common practice, but the main frame members continue of steel. There is a great possibility that frame channels can be made in the post war of extruded aluminum alloy sections, as they can be produced with simple tools, heat-treated, straightened and assembled with semi-skilled labor and without forging.

One would use a deeper beam than in the case of steel because of lower modulus of the aluminum base alloys. Engine bearers and other cross members will be of the same material. The undercarriage is conventionally of oak timber, but this is scarce, heavy, absorbs moisture and wears out rapidly. Moreover, considerable hardware is necessary for its use. Light metals should easily substitute for it.

The body readily suggests that light metals be used. In building up a girder, it is usual practice to coat the margin of the sheet with bitumastic paint before riveting into the tee slots. In fact, all hidden surfaces are best primed, to leave no space for moisture. It is well to interpose a packing strip of wood, fibre or rubber between the light-alloy member and the steel chassis frame.

On the European continent meat vans were built of light metals and had been in continuous service prior to the outbreak of war. Weight saved over the old style van was 1½ tons per vehicle, but because of greater margin of strength was able to increase payload by 6 to 8 tons.

—E. V. Pannell. *Light Metals* (British), Vol. 7, Nov. 1944, pp. 530-536.

Forming Thermosetting Plastics

Condensed from "Plastics"

Although phenolics have been regarded by the plastics industry as thermosetting and infusible, it has been shown in recent tests that fully cured, laminated phenolic sheets can be formed and drawn at high temperatures. The process, which promises to extend the field of application of the thermosetting materials considerably, consists of heating the sheets at temperatures above 300 F. for a few minutes, then placing in a press and forming similarly to thermoplastic resins.

Canvas-base laminates were chosen because they have higher impact strength than

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the paper grades, and because they blister less at high temperatures and atmospheric pressure.

The fact that properties such as creep may be increased ten times as temperature increases from 75 F. to 200 F., and that flexural strength, tensile and compressive strength, etc., decrease at elevated temperatures indicates that thermosetting materials "soften." In testing these resins to determine their high-temperature plasticity, they were loaded for about 10 sec. in the open, then covered with hot oil (about 350 F.) and the calculated load applied for 10 sec. The deformation at the center of the sheet was then recorded.

If the specimen is held in the oil too long before the load is applied, the additional cure of the material may interfere with its flow properties. Materials tested included Micarta 444, Formica CN-11, and several cured molded phenolics (wood flour filled). Results of tests were as follows:

Material	Thickness, in.	Time to reach ½ in. deform. at 400 F., 1000 p.s.i.
Grade C laminated phenolic	0.25	125 sec.
Formica CN-11	0.248	46 sec.
Micarta 444	0.227	72 sec.

The Grade C laminate was fully cured in the press prior to test. Its deformation rate increased almost seven-fold between 300 F. and 400 F.

The influence of curing time upon high-temperature flow is quite marked. A slight undercure in the laminate will assist forming. However, tests with 30-min. and 120-min. cured specimens indicate that even excessive overcure will not affect the hot formability of the laminated phenolic materials.

The test data conclusively demonstrate the thermoplastic properties of phenolic plastics at high temperatures.

—John Delmonte & E. Watkins. *Plastics*, Vol. 1, Dec. 1944, pp. 26, 28, 100, 101.

Light Metals and Plastics

Condensed from "Light Metals"

Closer collaboration between the plastics and light metals industries should be the rule, rather than an attitude of suspicion. In most cases, plastics and light metals complement each other rather than compete. Rarely are the two parallel competitors. Usually there is always an outstanding quality. Thus, plastics stand corrosion well; light metals have more strength.

There is often the feeling that light metals are merely competing with a waste product and hence are at a cost disadvantage. However, even where waste materials are the chief raw material the expense of the process equalizes costs.

Plastics are definitely synthetic, but in a sense light metals alloys are synthetic, the combination of metals being in percentages that will create a product best for the particular purpose in mind. Plastics are in no sense cheap, shoddy materials. Competition, as between laminated resin sheets and light alloy sheets in the aeronautical

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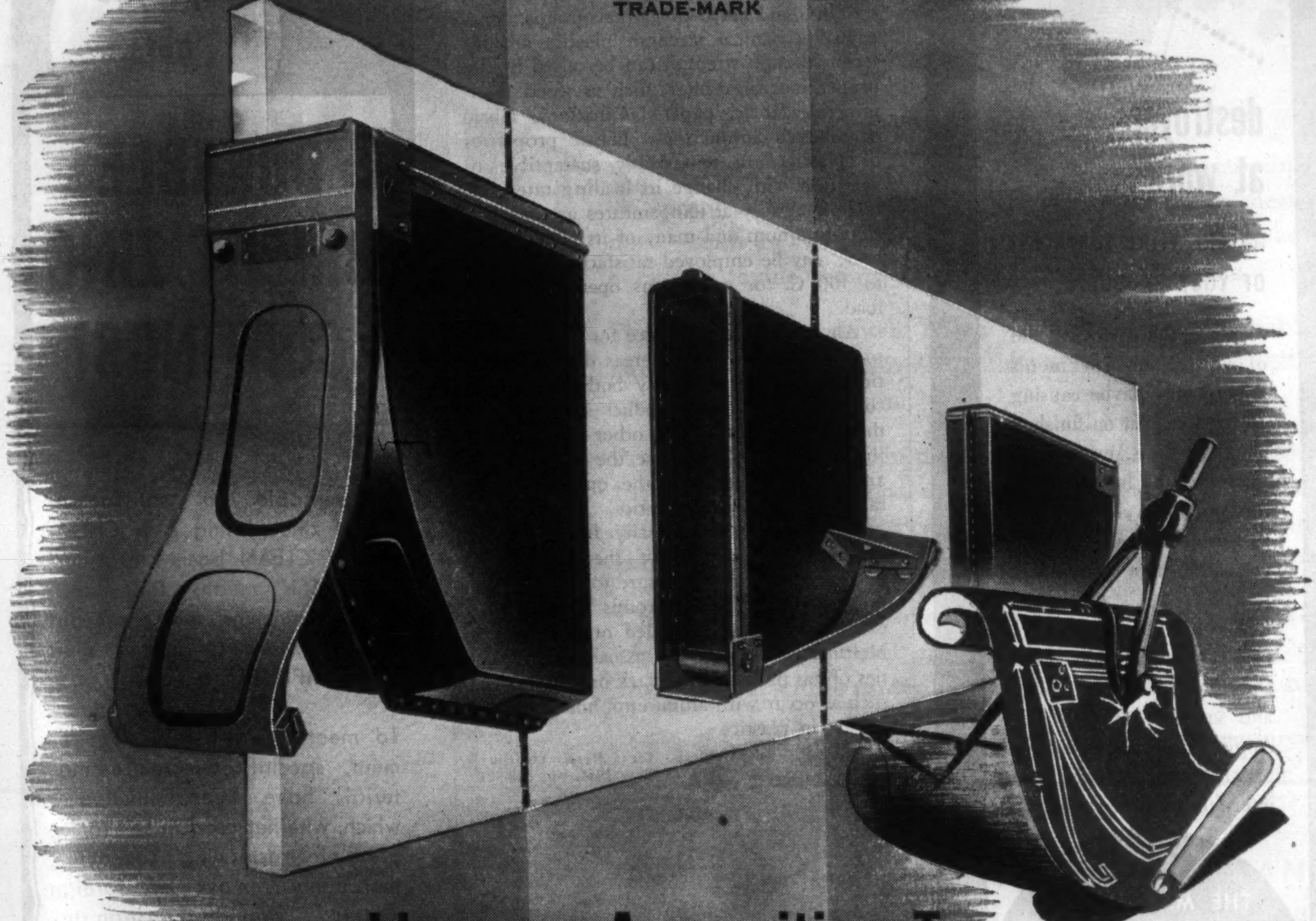

Ideas are Ammunition, Too

This is the largest item ever molded from BAKELITE phenolic molding board, BM-9725. It's an ammunition box for a bomber belly turret that packs looped lightning in the form of long belts of cartridges. It is 25½ in. by 17½ in. by 6½ in. in size. It is extremely lightweight, highly resistant to impact, abrasion, moisture, and chemicals, and has high tensile strength.

Until now, the plastics industry has used BAKELITE phenolic molding board chiefly for much smaller parts. The idea of employing its outstanding advantages for a large scale molding job was revolutionary, but has more than justified itself in a product that stands strenuous service, and is economically produced. Rigidity and extra strength are attained by molding the box from two sheets of BM-9725 around a sisal core that has been impregnated with phenolic resin. Both halves of the box are formed simultaneously in one cast iron mold. The press is equipped with banks of infrared lamps for preheating the mold charge and operates at a pressure of 1,000 pounds per square inch.

Ideas such as those that produced this box are ammunition for present and future planning—ammunition that hits the mark in product improvement and production economy. BAKELITE molding boards are available in sheets, blanks, and as diced material. They can be molded on existing equipment—either alone, or in combination with other BAKELITE plastics to reinforce vital points. Write Department 49 for full information and suggestions regarding molding techniques.

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industry, must ultimately benefit all manufacturers and users of both types of material.

The replacing of a substance with a plastic material should be based on a strength-weight/unit-area consideration. The most striking feature of plastics is their chemical inertness, being suitable for use with normal corrosive chemical reagents even at fairly high concentrations and elevated temperatures. The two materials merge where a strong light metal is protected by a paint containing plastic resins of the phenolic, cellulose and alkyd or glyptal groups.

In mechanical strength plastics are inferior, though strength can be raised by the proper inorganic filler, such as wood flour, mineral, fabric, paper laminations, fabric or asbestos laminations. Elastic properties of plastics are remarkably susceptible to variation with change in loading rates and fall off rapidly at temperatures around 100 C. Aluminum and many of its alloys, however, may be employed satisfactorily at 250 to 300 C. for continuous operation under load.

An interesting difference for the designer to remember is that whereas diluting plastics with some filler may both reduce the cost of the finished product and improve the quality, alloying of other metals with light metals may increase the cost at least and may not improve the quality to the same extent as with plastics.

There is some similarity in processing which equalizes costs of the two. Thus both need heat and pressure to produce the finished forms. Both groups can be cast, extruded, pressed, annealed or normalized. Melting problems, with associated difficulties of gas pick-up and attack on refractories, such as occur with aluminum, find no counterpart in plastics.

—Ronald Fleck. *Light Metals* (British), Vol. 7, Nov. 1944, pp. 518-521.

•

Low Temperature Properties of Elastomers

Condensed from "Journal of Applied Physics"

It is well known that high-polymeric materials, such as rubber and most of the synthetic rubbers, exhibit reversible, delayed elasticity under conditions of low strain. Application of a given, constant force produces, not a fixed deflection, but one that depends upon the duration of the force application.

The total strain can be considered as being made up of two parts, one an instantaneous deflection independent of time, the other a creep strain dependent on time. Results given here are what might be termed a "ten-second modulus," in which an interval of 10 sec. was allowed to elapse between time of application of the dead load and the recording of the deflection.

The four elastomers tested are of the butadiene-acrylonitrile type, with variation in acrylonitrile content the major difference. They are classified as Types 1, 2, 3 and 4, indicating decreasing content. The maximum allowable modulus is tentatively set at 10,000 p.s.i., as compounds having a

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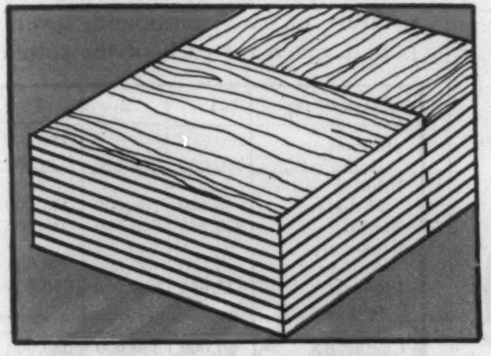
PREGWOOD is a relatively new material possessing many unusual qualities that have adapted it to many uses—such as switch gear in heavy duty switches, picker sticks on textile looms, ski bottoms on military skis.

The test figures shown below indicate the remarkable strength of the material—which has a lower specific gravity than aluminum.

Pregwood has a certain measure of efficiency as an electrical insulator. It is non-absorbent and does not take up moisture. It is chemically inert and can be used for apparatus parts that will be exposed to acids and alkalies.

Changes in humidity have relatively little effect on dimensions; and a low co-efficient of thermal expansion holds the material stable under marked changes in temperature.

It has the quality of wearing smoothly without slivering or cracking. This makes it especially desirable for parts of textile machinery where it will not snag threads of fabrics.



Pregwood is built up by impregnating wood laminations with phenolic resins and pressing them together under heat and pressure. The laminations may be arranged with grain running one direction. This method produces high strength products such as Pregwood 1100.

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Test samples are available on request— **FORMICA**

higher value would not be of much use as rubberlike material in service.

The general stock formula adopted was: Polymer, 100 parts by wt.; softener, 20 parts; SRF black, 70 parts; zinc oxide, 3 parts; sulphur 2.5 parts; benzothiazyl disulphide, 1 part.

Both modulus and brittleness tests indicated that the low temperature characteristics improved progressively as the amount of acrylonitrile present was reduced. Both tests also indicate that Cumar BX, though effective as a softener at normal temperatures, stiffens rather than softens the compounds at low temperatures. Brittle point temperatures for each of the four types of compounds studied, with softeners as given, are:

Polymer type	1	2	3	4
Softener				
None	−17 C.	−27 C.	−41 C.	−56 C.
Dibutyl phthalate	−26	−34	−44	−55
Bardol	−22	−26	−38	−55
Di-isobutyl adipate	−23	−34	−44	−56
Dibenzyl sebacate	−37	−43	−55	−63
Cumar BX	− 8	−16	−36	−47
Plasticizer SC	−32	−40	−49	−60

The modulus at the brittle point temperature of each compound, given in p.s.i., is here given for each of the softeners:

Polymer type	1	2	3	4
Softener				
None	450,000	780,000	730,000	675,000
Dibutyl phthalate	36,000	260,000	275,000	325,000
Bardol	320,000	340,000	315,000	550,000
Di-isobutyl adipate	5,300	27,000	50,000	85,000
Dibenzyl sebacate	125,000	260,000	550,000	200,000 (est.)
Cumar BX	50,000	340,000	630,000	510,000
Plasticizer SC	51,000	180,000	160,000	200,000

At temperatures around 30 C., the ten-second modulus approaches the so-called total modulus. At low temperatures, when primary creep takes place very slowly, the ten-second modulus is nearly identical with the instantaneous modulus.

At intermediate temperatures the measured ten-second modulus depends, in varying degree, on both the total and instantaneous moduli. At these intermediate temperatures the ten-second modulus can be employed as a serviceability unit.

—F. S. Conant & J. W. Liska. *J. Applied Physics*, Vol. 15, Nov. 1944, pp. 767-778.

Compreg—Wood and Plastic

Condensed from "Mechanical Engineering"

When rotary-cut maple veneer is impregnated with a phenolic resin in solution, the solvent dried off, and the material compressed under heat and pressure, the resulting product is called "compreg." It may be said to lie between the plywoods and the plastic laminates.

Among the properties of the new material are high moisture resistance, rot and insect resistance, excellent compression-bearing value, and good stiffness. While the resin does not add appreciably to the true tensile strength, the product is stronger per sq. in. because more fibers are in a square in. The

RESEARCH -*Basic Reason for Better Carbides*

Years of unrelenting research by Philip M. McKenna resulted, in 1937, in the discovery of the hardest man-made material—a unique intermetallic compound, tungsten-titanium-carbide, corresponding to the chemical formula $WTiC_2$. This compound is the basic ingredient of steel-cutting compositions of Kennametal. It distinguishes them from all other cemented carbides.

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- *a series of Kennametal compositions, of varying degrees of hardness, strength, and toughness, exactly suited for machining various types of steel, as well as tough, stringy non-ferrous alloys.*
- *a new, highly abrasion-resistant tungsten carbide Kennametal composition that cuts cast iron at greatly accelerated rates, with amazing tool life.*
- *a complete line of machining tools, designed to make fullest utilization of possibilities inherent in Kennametal compositions.*
- *Kennametal lathe files, that outlast steel files up to 200 times, and produce a superior finish.*
- *a wide variety of wear-resistant products, including lathe and grinder centers, pump valve balls and seats, gage tips, etc.*
- *negative-rake carbide milling cutters, notable among which is the widely used inserted-blade Kennamill step-cutter.*

Research—looking to still further improvements in the properties and applicability of Kennametal—will continue, and expand, so long as the useful products of inventive genius are protected under an uninhibited American system of free enterprise

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Think of the great strides plastics have achieved to meet the challenges of war needs. If your peacetime production plans include the use of advanced plastics, we urge you to consult our Technical Service Department. Its staff welcomes challenging problems of reconversion.

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tensile strength per lb. across the grain direction has been markedly improved. Shear parallel to the grain has also been improved.

Synthetic resin is added to the extent of about 20%, somewhat less than the amount of natural binding agents in the wood. Because these natural binders are particularly sensitive to overcure, sheets over 2 in. thick are not made by the heated-platen-type pressing process. High-frequency electrical heating is used for the heavier sections.

The materials will have a density of about 1.35, about twice that of the wood used. Choice of wood used will affect the properties to some extent. Maple has been found to give higher shear values than woods with a straighter grain, such as birch.

A test made with hemlock showed unusually high values for modulus of elasticity, while redwood gave water resistance results above the ordinary. However, it was noted that impregnating and compressing the various species of woods tends to bring their properties more nearly alike.

—John F. Dreyer. *Mech. Engineering*, Vol. 66, Nov. 1944, pp. 710-712.

Plated Plastics

Condensed from "Plastics"

Plating on non-conductive surfaces has intrigued the electrochemist almost from the origin of commercial plating methods. By plating, the manufacturer often creates a metallic article which could not be achieved by mass production with a metal base.

When war came, engineers adapted the method to delicate commutators, barometric instruments, tube bases, etc., where electrical conductivity was wanted on one side and insulating properties on the other. Metal plated plastics are stronger than unplated plastics.

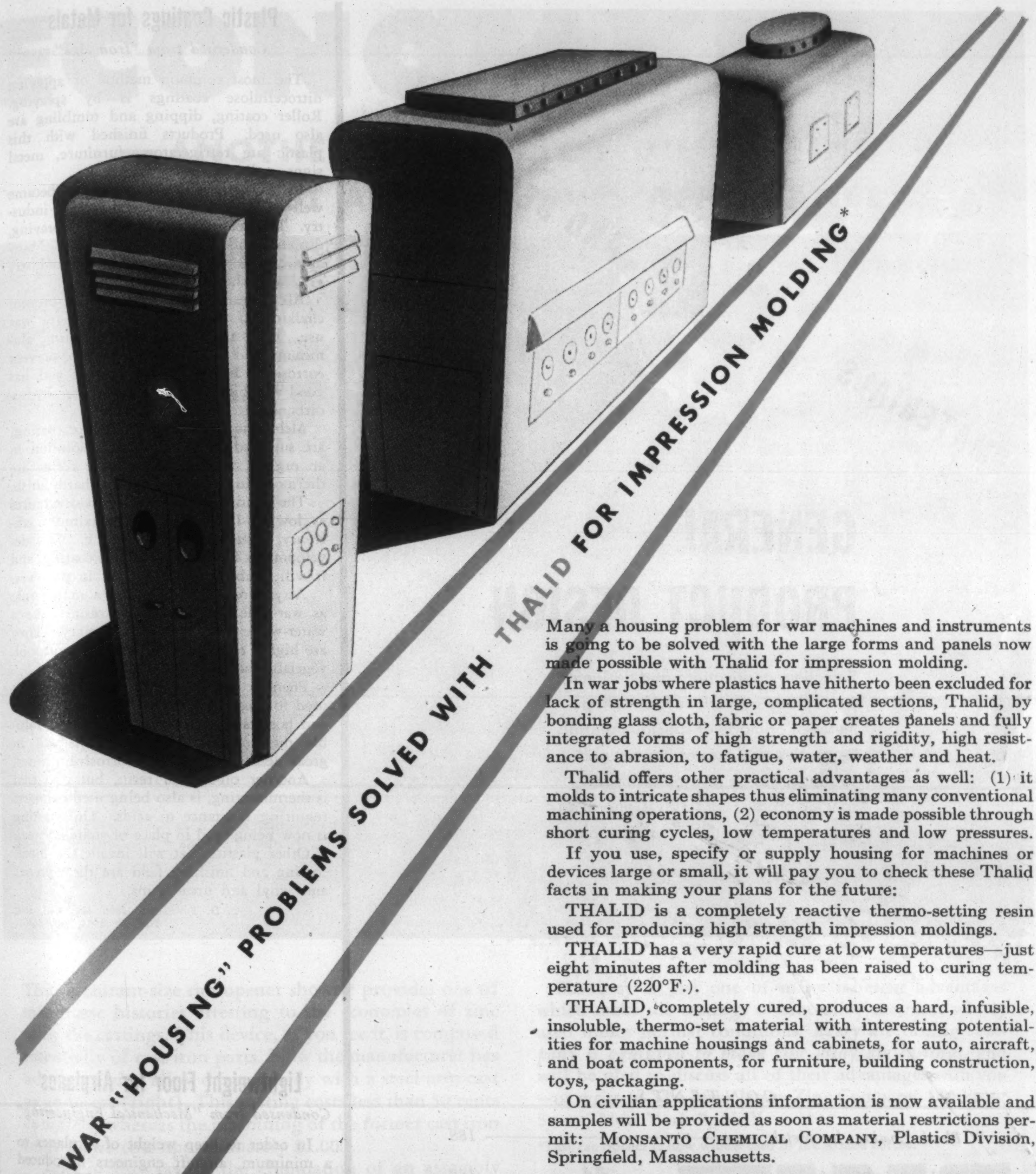
An interesting application is the plastics-plywood antenna mast on a fighter plane, plated with a thick copper coating. Vibration on this aircraft is high, as are wind velocities. A good possibility is a laminated phenolic safety helmet, good for sportsmen in the tropical sun, or workers in shipyards where mechanical and temperature protection are needed. Such a helmet is 50% cooler than one of aluminum.

Plating of plastics brings out the detail in the molded piece, metal highlighting the design. A great future is in automobile hardware, particularly since the public has become metal-hungry during the war years of restriction. Such hardware would have good physicals.

Where hardware is metal plated over metal, the plating often peels off or forms pinholes. There is no galvanic action between plastics and metals. In cost it would be competitive with all-metal items.

Trim strip, dash knobs and other accessories may well be converted to plastic-plated materials. It is believed that the public again wants the "feel" of metal and for the time being is fed up with the daintily-colored plastic gadgets on automobiles.

—R. R. Dickey. *Plastics*, Vol. 1, Nov. 1944, pp. 32, 34, 102-103.



WAR "HOUSING" PROBLEMS SOLVED WITH THALID FOR IMPRESSION MOLDING*

Many a housing problem for war machines and instruments is going to be solved with the large forms and panels now made possible with Thalid for impression molding.

In war jobs where plastics have hitherto been excluded for lack of strength in large, complicated sections, Thalid, by bonding glass cloth, fabric or paper creates panels and fully integrated forms of high strength and rigidity, high resistance to abrasion, to fatigue, water, weather and heat.

Thalid offers other practical advantages as well: (1) it molds to intricate shapes thus eliminating many conventional machining operations, (2) economy is made possible through short curing cycles, low temperatures and low pressures.

If you use, specify or supply housing for machines or devices large or small, it will pay you to check these Thalid facts in making your plans for the future:

THALID is a completely reactive thermo-setting resin used for producing high strength impression moldings.

THALID has a very rapid cure at low temperatures—just eight minutes after molding has been raised to curing temperature (220°F.).

THALID, completely cured, produces a hard, infusible, insoluble, thermo-set material with interesting potentialities for machine housings and cabinets, for auto, aircraft, and boat components, for furniture, building construction, toys, packaging.

On civilian applications information is now available and samples will be provided as soon as material restrictions permit: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield, Massachusetts.

*Impression molding: a term covering the field variously described as low pressure molding, contact laminating, cast laminating or no pressure laminating.

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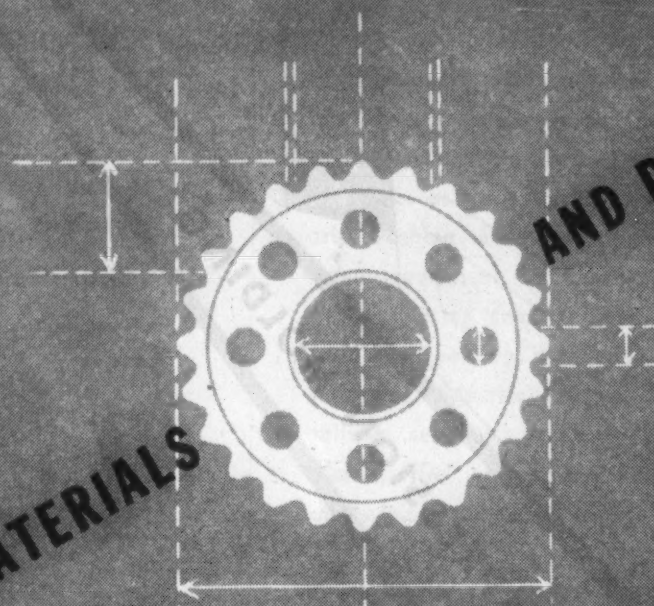
MATERIALS AND DESIGN



GENERAL PRODUCT DESIGN

Selection, applications and design of parts made by various fabricating methods or made of special materials. Properties and uses of finishes and coatings. Design and materials for specific products or fields. General engineering design trends or principles.

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Plastic Coatings for Metals

Condensed from "Iron Age"

The most common method of applying nitrocellulose coatings is by spraying. Roller coating, dipping and tumbling are also used. Products finished with this plastic are refrigerators, furniture, metal signs, radiators, etc.

In the early 1930s alkyd resins became well established in the metal coating industry. The coatings are applied by spraying, dipping, roll coating and brushing. Many applications were baked, but the industry gradually changed to air drying.

Alkyd resins have been used to prevent chalking in the lusterless finishes for war use. They are being used in coating aluminum and light metal parts to prevent corrosion. It is a durable plastic and has good flexibility, but is soluble in hydrocarbons.

Melamine resins used in surface coatings are supplied in the form of a solution in an organic solvent. Since these resins are thermosetting, they produce a hard finish. The coatings will bake at temperatures as low as 180 F., but for maximum efficiency, should be 325 to 425 F. War developments have improved this coating, and it will doubtless be important in post-war.

Acrylic resins have played a major role as war-time coatings. These resins have a water-white color and transparency. They are highly resistant to mineral oils, alcohol, vegetable oils and chemical fumes.

Phenolic resins in war-time have been used for coating water tanks, steel canteens and hospital food containers. The oil-soluble thermoplastic phenolic resins are in great demand as an anti-corrosive primer.

Another oil-soluble resin, but one that is thermosetting, is also being used on parts requiring resistance to acids. This coating is now being used in place of stainless steel.

Other plastics that will invade the metal coating and finishing field are the styrenes and vinyl and urea resins.

—C. D. Townsend. *Iron Age,* Vol. 154, Nov. 2, 1944, pp. 56-57.

Lightweight Floor for Airplanes

Condensed from "Mechanical Engineering"

In order to keep weight of airplanes to a minimum, aircraft engineers introduced hollow-core plywood flooring. This material may be used in both flat and molded form.

A special type of hollow-core panel with plywood faces was developed, consisting of birch throughout with a core in which the rails and grid are airplane spruce. Panels were made with phenolic-resin glue, hot-plate process, and were also applied to the core with phenolic glue.

Test specimens were: Panel A, 24 by 12 by 0.778 in., with 1/16-in. 3-ply birch face, and 3/64-in. 3-ply birch back; spruce core, wt. 0.83 p.s.f.; Panel B, 24 by 12 by 0.743 in., with 1/16-in. 3-ply birch face,

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Add to this saving the elimination of an assembly operation in fastening the arm to the body. Take into account, also, the improved appearance due to the smooth as-cast surface of the die casting. The result is typical of the economic and physical improvements achieved in many widely varied products today through the intelligent use of zinc alloy die castings.

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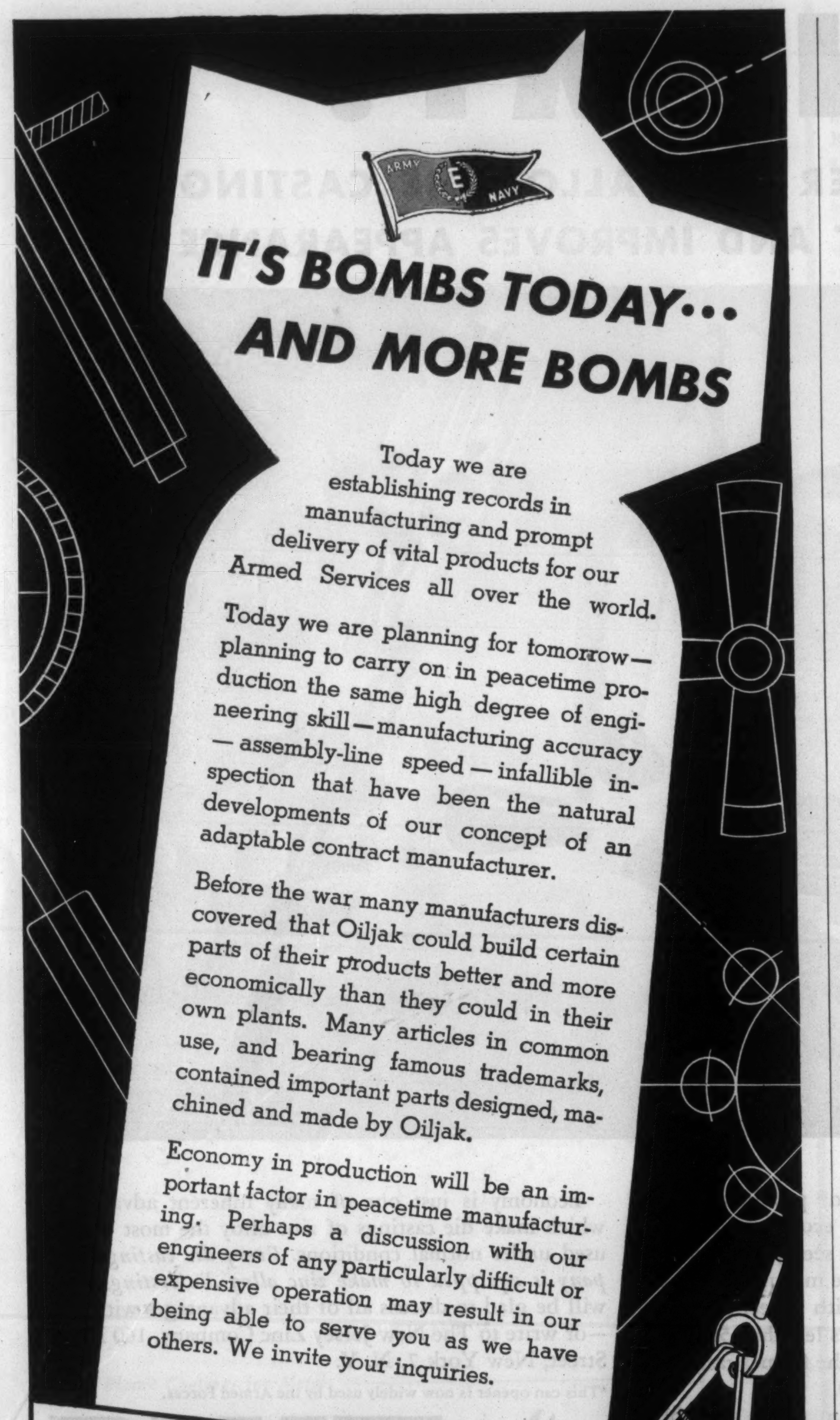

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and 3/64-in. 3-ply back; basswood core, wt. 0.82 p.s.f.

The following tests were made: Bending, as simply supported beam over a span of 18½ in., with concentrated load across center of panel; bending, as simply supported beam over a span of 18½ in., with concentrated load in center of panel and covering an area of one sq. in.; crushing strength, with concentrated load covering area of one sq. in. in position between grids, over one grid and over cross-grids; and shock resistance, with beam fixed at both ends over a span of 18½ in. by means of a cylindrical bag 6 in. in diam., filled with 50 lb. of shot and dropped from a height of 8 in.

In the crushing test, both specimens failed in horizontal shear along the glue line between plywood and grid core. Panel A supported a load of 600 lb. with a deflection of 0.33 in. Panel B supported a load of 500 lb. with a deflection of 0.292 in. Both panels can support a load of 300 lb. at the center concentrated over an area of one sq. in. Panels with a fixed end withstood the shock of the 50 lb. shot dropped from a height of 8 in.

Both floor tests were ¾ in. thick and weighed 0.8 p.s.f. In small panels, rails add to the p.s.f. weight. Ramps used for loading were designed 9/16 in. thick, and carried a test load of 500 p.s.f., with a deflection of 15/64 in.

In the final test before acceptance, the floor carried a load of 800 p.s.f. over an 18-in. span with a deflection of 3/16 in. Eventually the thickness of the floor was reduced from ¾ to 11/16 in., and a 4-ply panel was substituted (3 of basswood and one of fiber).

While primarily this floor was designed for aircraft, it can be adapted to many other forms of transportation equipment. Perhaps its best application would be in the bus field. Other fields of application are in railway coaches, street cars, truck trailers, etc.

—J. R. Fitzpatrick. *Mech. Engineering,* Nov. 1944, pp. 705-709.

Acid Corrosion of Alloy Steels

Condensed from a Preprint of the Electrochemical Society

Machines for spray pickling brass cartridge cases with hot, dilute sulfuric acid consisted of lead-lined "tunnels" through which the work was carried in stainless steel crates over stainless steel rollers or conveyors. Special alloy steel pumps pumped the acid through spray nozzles directed against the work. Stainless steels of the 18-8 or 18-8-Mo type were used successfully in these machines when brass cartridge cases were being pickled, but when production was changed over to steel cartridge cases, these stainless steels were no longer sufficiently corrosion resistant.

Worthite (20-24-3 Cr-Ni-Mo alloy) pumps which were used on most of the

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pickling machines showed no immediate signs of corrosion, and worthite rolls were widely introduced in place of stainless steel rolls. In a short time, reports were received from various plants of serious corrosion of worthite pumps and rolls.

Laboratory investigations, followed by plant tests, showed that at the conditions existing in the pickling machine, worthite, which is normally cathodic to lead when in contact with the pickle solution, was actually anodic. Furthermore, it was determined that this anodic, activated condition of the worthite was the result of exhaustion of oxygen from the solution. The presence of at least some traces of oxygen in the solution seems to be necessary for nickel-chromium alloys to form or maintain a passive film in hot, weak, sulfuric acid solutions.

Cathodic protection by an impressed counter potential on the worthite parts was tried, but the equipment required to effect the proper distribution of current was too elaborate. Addition of an oxidizing agent, sodium chromate, to the solution was found to be completely effective. A concentration of 0.1% (1 g, per 1.) was used. After 6 months it was found that a smaller concentration of sodium chromate was effective.

A similar problem in the handling of oil refinery sludge, which is 50% sulfuric acid, at 200 F., in alloys similar to worthite, in contact with lead piping and tanks, was traced to deaeration. A baffle chamber built in the pump supply tank, through which the acid flowed and into which low pressure air was introduced, eliminated the corrosion difficulties.

—W. E. Pratt. *Electrochemical Soc.*, Preprint No. 86-5, 27 pp. Oct. 1944 meeting.

Flexural Strength of Extruded Magnesium

Condensed from
"Journal of the Aeronautical Sciences"

A problem exists in the use of magnesium alloys in aircraft of determining the resisting moment in bending. Special methods and theories have to be used to predict these values because of the lower yield strength of wrought magnesium alloys in compression as compared with tension.

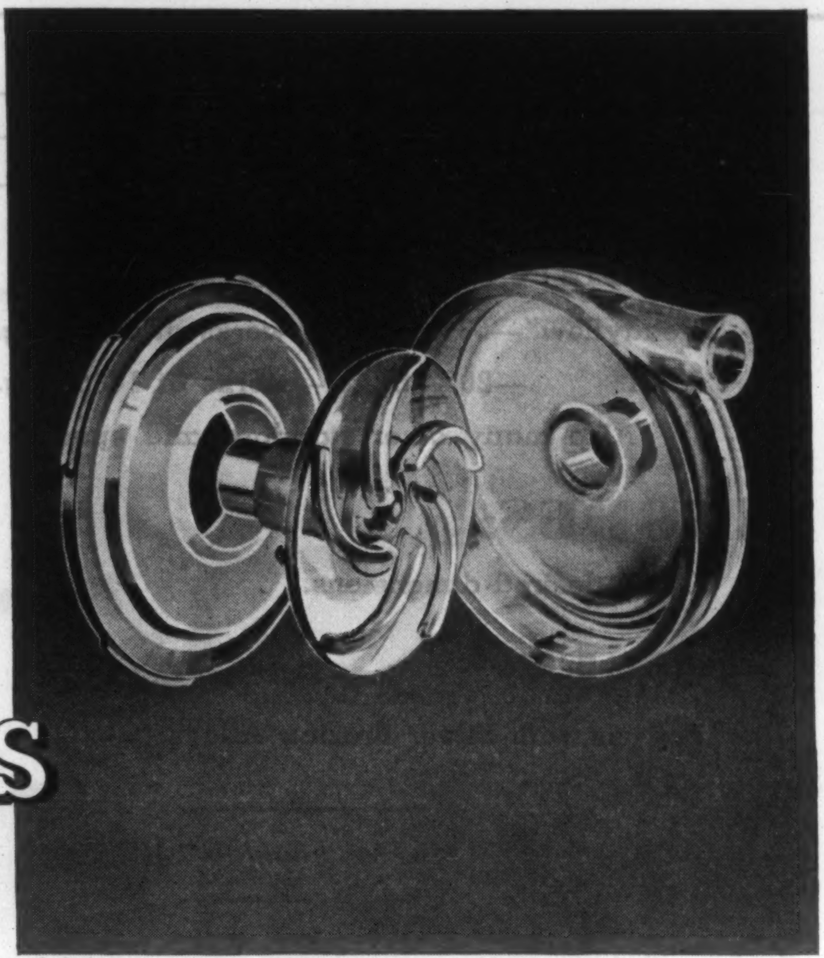
It has been the general engineering practice to use the classic bending theory to determine the strength of beams in bending—that plane sections before bending remain plane after bending and, in the elastic range, the stress is proportional to the strain.

In present practice there are a number of aircraft materials that have low proportional limits. Since the classic formula no longer holds above the proportional limit, it is evident that some more accurate method of analysis should be developed.

Wrought magnesium alloys usually have a compressive yield strength less than the

FROM CHRISTMAS TREE ORNAMENTS TO

GLASS PUMPS



WHEN war cut off America's supply of imported Christmas tree ornaments, Corning stepped into the picture . . . adapted its production facilities to turn them out at the rate of hundreds per minute. And they were better, more rugged, more brilliant.

When chemical plants handling highly corrosive materials complained that their metal pumps were being eaten away almost as fast as they were installed, Corning was consulted. In cooperation with the Nash Engineering Company, a pump was developed in which the material being handled came in contact only with corrosion resistant PYREX brand Glass. Today these pumps are in constant day-in and day-out service.

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tensile yield strength. Thus, when a beam is subject to flexure, symmetrical about a horizontal axis, the outermost fibers on the compression side of the beam may be strained in the plastic region, while the outermost fibers on the tension side are still strained elastically. The position of the neutral axis then shifts toward the tension side to compensate for this difference in strain of the outermost fibers, meaning that more material is in compression than in tension.

A jig was designed so that third-point loading could be obtained. The distribution of strain is seen to be linear, thus proving that plane sections before bending remain plane after bending.

—F. A. Rappleyea & E. J. Eastman. *J. Aeronautical Sciences*, Vol. 11, Oct. 1944, pp. 373-377.

Abrasion-Resistant Metals

Condensed from "Zeitschrift für Elektrochemie"

This investigation deals generally with the metals and alloys used in contacts, sliding resistances, and current collectors for electrical apparatus, but mainly with those used in the points of fountain pens, where abrasion takes place without any chemical, thermal or mechanical effects except the slight pressure applied. The best alloy used so far is an osmium alloy with over 80% osmium.

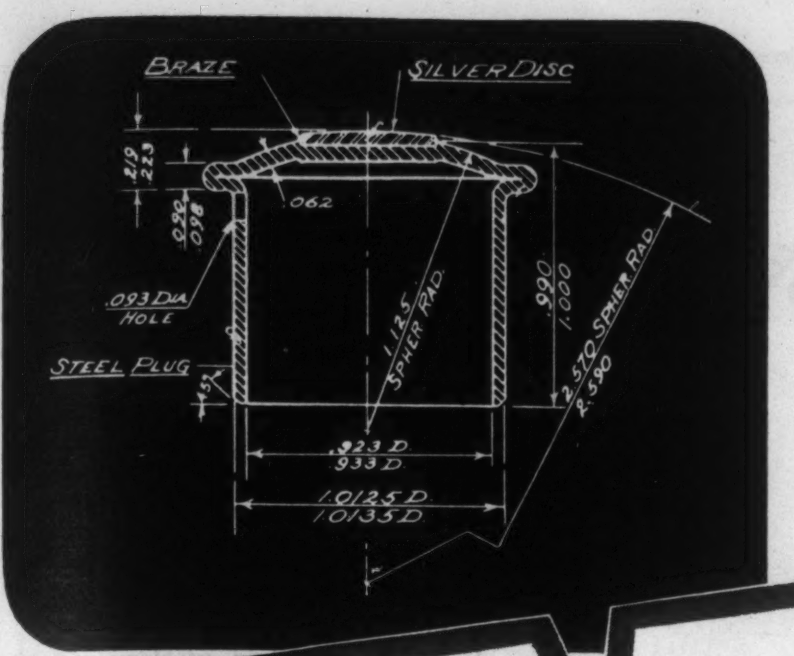
Special tests with rare metals and base metals of high melting point are compared with those of iron-carbon alloys and with widia. A close connection was found in the pure metals between abrasive strength and order number. In most cases the determination of the abrasive strength can be replaced by the simpler measurement of the scratch hardness.

Two possibilities lend themselves for the development of an alloy with high abrasive strength on a given basic pure metal: (1) Addition of a metal with high abrasive strength, which, however, requires considerable quantities to obtain a noticeable improvement; and (2) addition of an element which causes structural changes in the direction of mechanical strengthening. Metalloids, such as carbon and boron, are particularly suited for this purpose, as exemplified by the Fe-C alloys and the hard metal carbides.

In this manner, the rare osmium could be replaced by the not-so-rare rhenium with addition of boron, which has an abrasive resistance very close to osmium. Other alloying elements increased the toughness without impairing hardness and thus resulted in an even higher abrasive strength.

A generalization of these results for other abrasive processes under high pressure and eventual chemical attacks is not advocated.

—O. Winkler. *Z. Elektrochemie*, Vol. 49, Apr./May 1943, pp. 221-228.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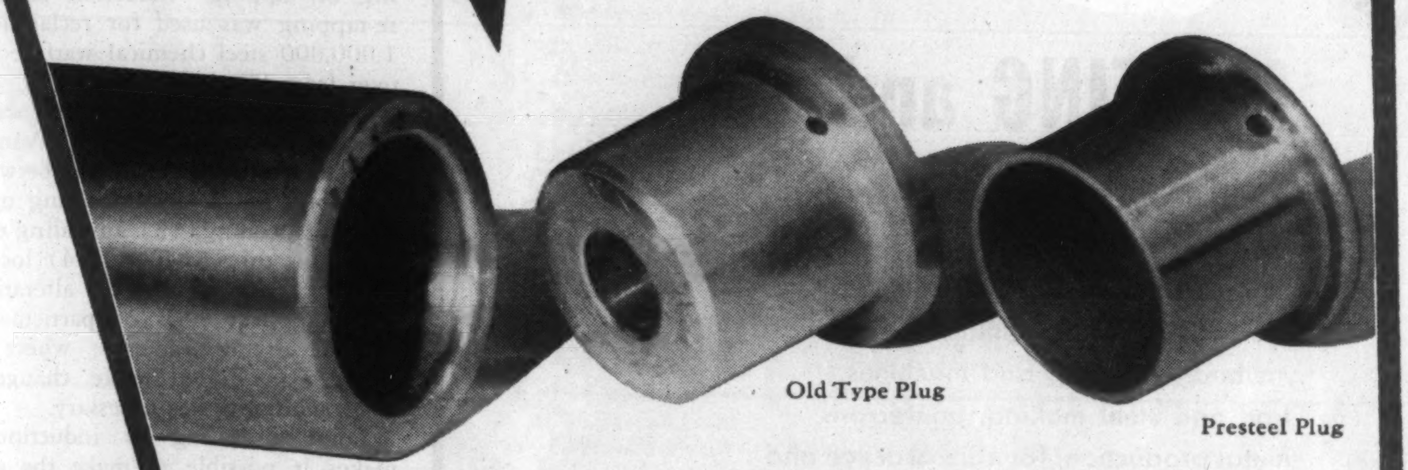
1.000
2.570 SPHER RAD.
2.590
.923 D
.933 D
1.0125 D
1.0135 D

Detail Drawing of the Steel and Silver Plug



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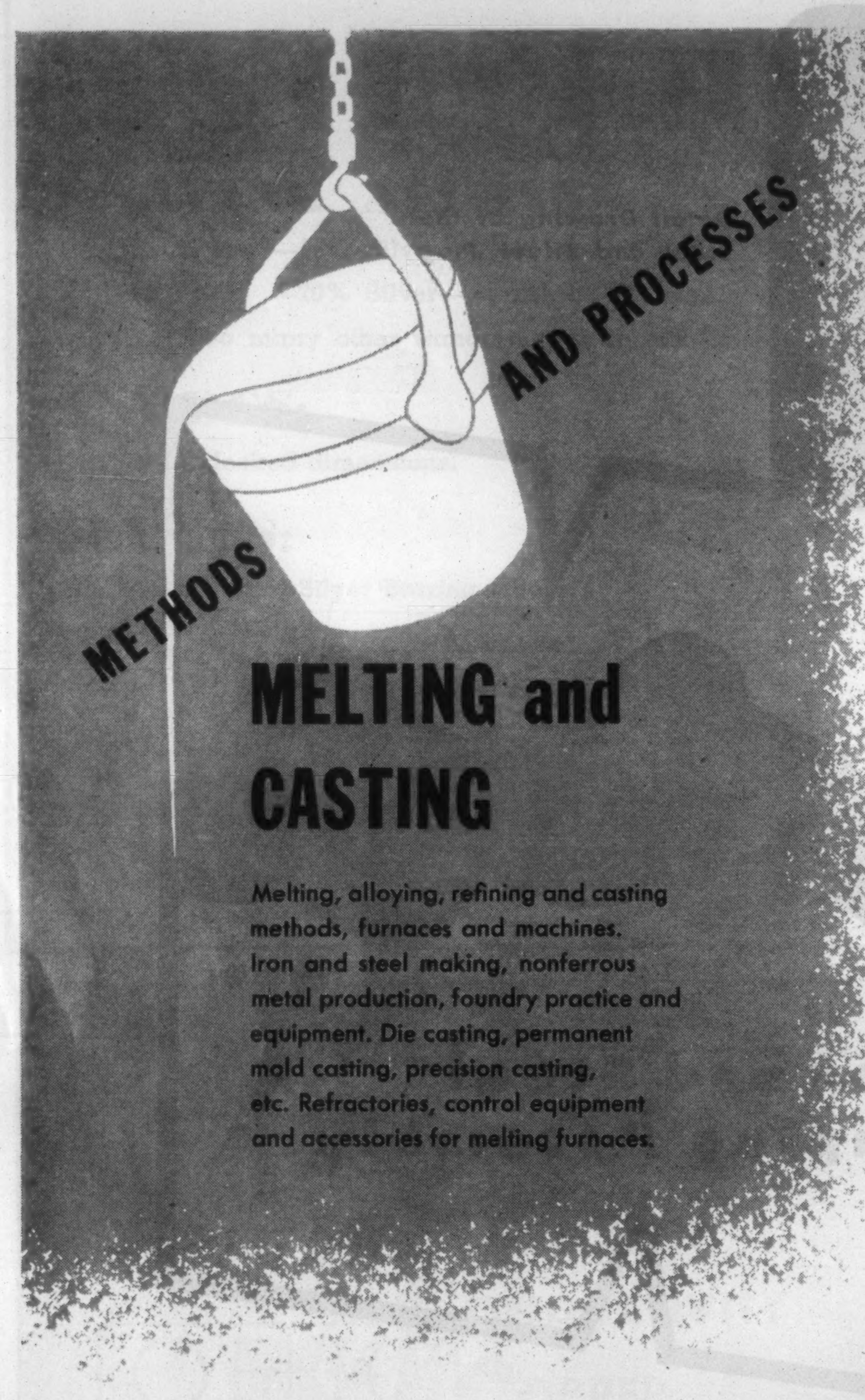

METHODS AND PROCESSES

MELTING and CASTING

Melting, alloying, refining and casting methods, furnaces and machines. Iron and steel making, nonferrous metal production, foundry practice and equipment. Die casting, permanent mold casting, precision casting, etc. Refractories, control equipment and accessories for melting furnaces.

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Induction Heating for Melting and Annealing

Condensed from "Transactions," Electrochemical Society

Induction heating, although being used more and more in all types of heat-treating operations, is by no means a universal form of heating, and does not replace or provide a substitute for fuel-fired furnace treatment.

If the following three requirements should be met, induction heating is applicable: (1) If it is desired to localize the heat to the surface of the metal; (2) if it is desired to localize the heat to a specific section of the article; and (3) if rapid heating is required to prevent oxidation, scaling, or decarburization.

Very few annealing problems involve surface annealing. One of the infrequent applications is surface annealing for threading or tapping. Induction annealing for re-tapping was used for reclaiming nearly 1,000,000 steel chemical warfare shells left over from World War I.

The annealing of restricted areas on an article is required in (1) Annealing of steel and brass cartridge cases between drawing operations; (2) annealing of ends of pins for peening; (3) annealing of ends of shafts for threading; and (4) local annealing of large steel dies for alterations. The latter application is of particular interest in the aircraft industry, where frequent changes in design make changes in the large stamping dies necessary.

Local annealing by induction heating makes it possible to make the alterations without annealing and re-hardening the entire mass.

Rapid Heating

Cases where rapid heating is desired include the continuous heating of steel tubing, strip and wire, to reduce oxidation and overcome the time lag required to heat such sections in a conventional furnace. Usually the speed of such lines is so great that if the annealing is incorporated in the same line an excessively large high frequency capacity is required, but it is often economical to re-run the material through an induction anneal at a lower speed.

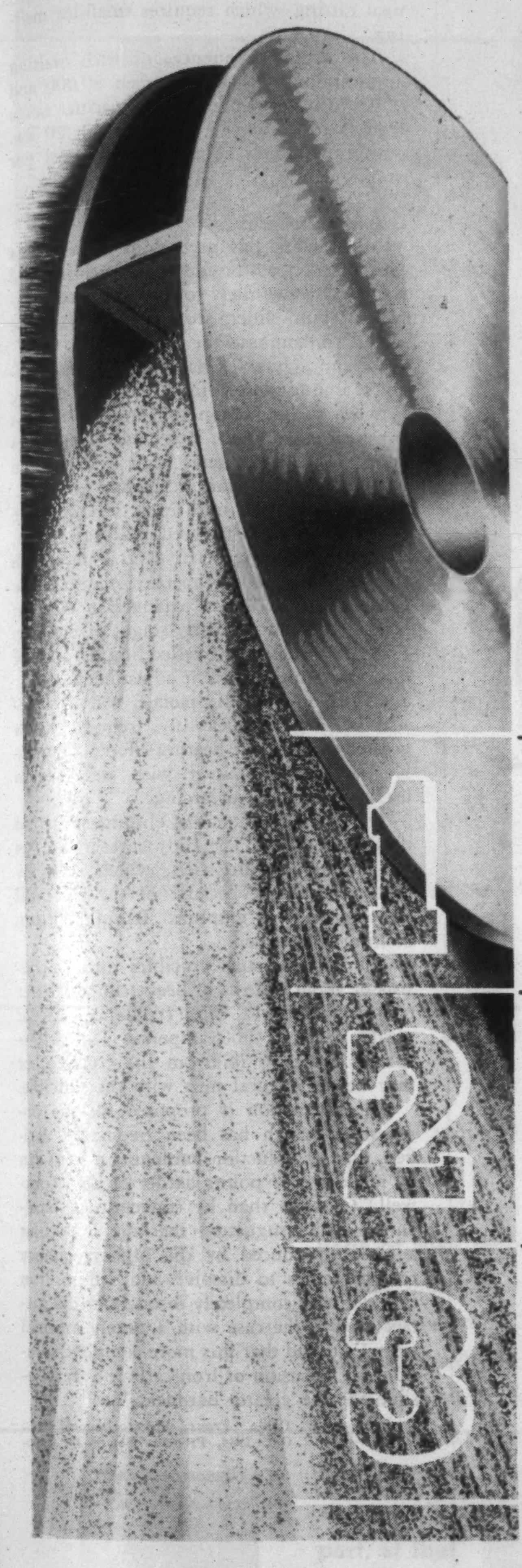
Where retarded cooling rates are required, combinations of induction heating and fuel-fired furnaces may be used, where the former brings the metal rapidly to the desired temperature and the latter holds it there or carries it through a pre-determined cooling cycle.

The energy requirement in induction annealing is low compared with that for induction hardening. Usually about 2 kw. per sq. in. is used for annealing and 5 to 10 kw. per sq. in. for hardening.

Induction melting was first developed to a practical operation by Dr. E. F. Northrop. Large melting furnaces using relatively low frequencies are found in many steel mills throughout the world today. Variations in design make a discussion of such equipment impossible in a limited space.

It is felt that there is more general interest in small crucible units with a capacity of about 20 lb. A furnace of this size has extreme flexibility for laboratory and small production use, especially at the present

Barrage Against *Time*



EVERY production operation represents a closely calculated MEASURE OF TIME. In metal cleaning, the time factor is usually responsible for high costs. It is the important element to watch.

As time is cut, costs are cut also. The airless Wheelabrator lays a veritable barrage against time. It saves machine and labor time on cleaning, inspection, machining and grinding time.

Its cleaning action is consistent . . . the finish is uniform . . . there is less fluctuation in production . . . therefore, present and postwar contracts can be estimated more closely and at a lower figure.

More and more manufacturers are leveling a barrage at time costs by replacing outmoded methods of metal cleaning with the Wheelabrator. In planning for highly competitive postwar markets consider the advantages of this modern method as reflected in the following statements of users:

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"Reduced cleaning time approximately 50%."
"5 hours' former cleaning time reduced to 15 minutes."
"60 man-hours of cleaning time reduced to 7 man-hours with the Wheelabrator."
"32 hours' cleaning time reduced to 7 hours."
"Time cut from 24 hours to 8 hours."
"We are cleaning castings in half the former time."

SAVED ON COSTS

"Reduced direct labor cost 50%."
"Saved 300 cubic feet of air per minute."
"Saved 75% of our labor in cleaning."
"Low cost per ton, in fact lower than we have ever cleaned castings before."
"Cleaning now with 4 less operators."
"Maintenance costs are 1/3 of sandblasting equipment."
"Our electric bills have been cut almost in half."

SAVED ON MACHINING, GRINDING, INSPECTION

"Decided increase in tool life between grinds."
"Considerable saving in grinding and grinding wheel costs."
"Wheelabrating shows up any minor surface imperfections."
"Considerable saving in our Machine Shops, from extra tool life."
"Tool wear and breakage materially cut down."
"Appearance and machinability are much improved over tumbled casting."

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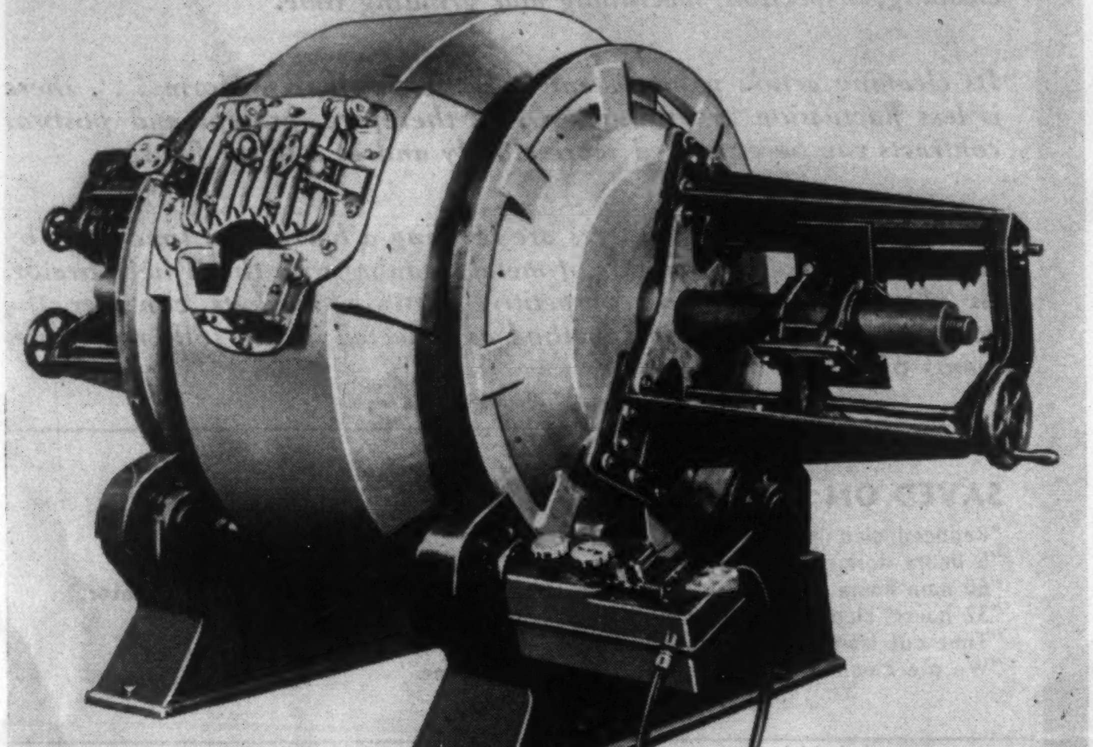

man-hour. They produce as many as 8 ferrous or 16 non-ferrous heats in one eight-hour day. Because of their precise metallurgical and operating control, Detroit furnaces assure quality results and maximum economy.

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time in conjunction with precision centrifugal casting, which requires small-lot melting.

The supply frequency for such melting applications is usually between 80,000 and 400,000 cycles per sec., and capacities range from 5 to 20 kw. A furnace with 20 kw. output will melt about 1 lb. of steel per min.

Graphite Crucibles

Much work has been done on the best type of crucible for induction melting, and the trend is definitely toward graphite crucibles. Ceramic liners are used if the graphite would contaminate the melt.

Ceramic crucibles have several disadvantages, among these being: (1) The spacing between the induction coil and the melt is so great that large magnetic flux losses occur. This necessitates high currents and voltages and attendant arcing hazards.

(2) When the melt itself serves as the conductor for the induced heating current, changes in loading occur as a result of the change in magnetic properties of steel at the Curie point, or due to changes in position of the stock during early stages of melting. This may result in overloading or loss of load after initial current adjustment.

(3) Non-magnetic metals, with low resistivity and permeability, require much greater currents for heating effects comparable to those obtained with steel, again leading to danger of arcing.

The graphite crucible eliminates all of these difficulties. The eddy currents are set up in the graphite itself, which heats by induction readily because of the electrical characteristics of graphite. Rapid, uniform melting is obtained.

The coil for such crucibles usually consists of about 6 turns of heavy copper, water cooled, carrying a high frequency current of the order of 500 amperes. The coil is spaced about ¼ in. from the crucible, or may be an integral unit with the crucible.

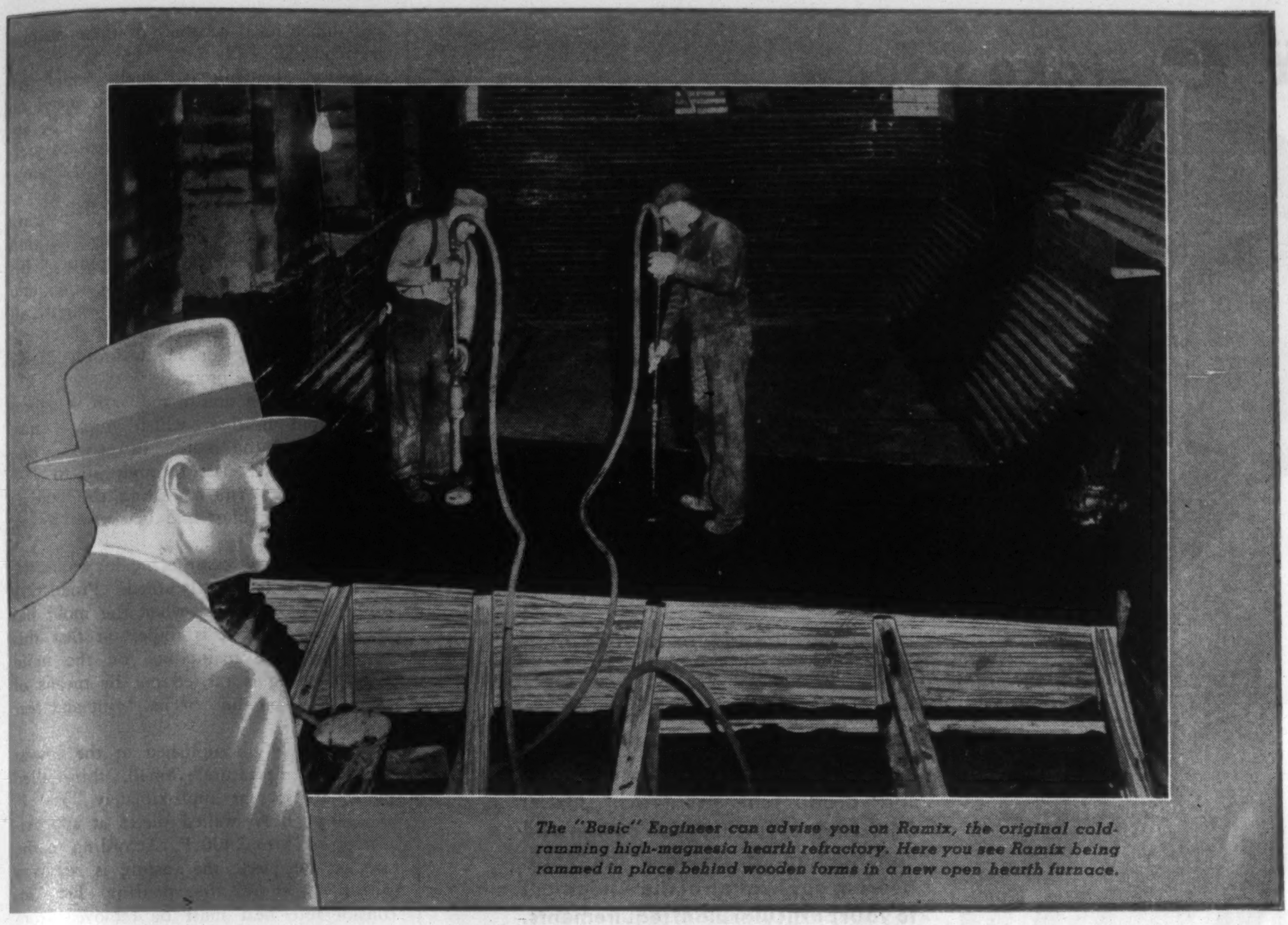
An explanation is proposed for the observation, which has been frequently verified, that by induction hardening a steel can be made 2 to 7 points harder on the Rockwell "C" scale than by conventional hardening. It is suggested that the molecular agitation produced by the high frequency current serves to dissolve and diffuse iron carbide more completely throughout the matrix than is the case with a purely thermal treatment, and that this more complete solution and diffusion of iron carbide is responsible for the greater hardness.

—J. W. Cable. *Trans.*, Electrochemical Soc., Oct. 1944, Preprint No. 86-18, 6 pp.

Gray Iron Castings in Metal Molds

Condensed from "Die Giesserei"

From the economic point of view, the use of metal molds can be justified only where large numbers of identical castings are to be produced; while from the technological point of view, its application can be justified only where the high density



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Back of the "Basic" Sales Engineer is an organization with just one goal—to supply the kind of dependable refractories and service that steel makers need and want. So don't hesitate to call him in—to discuss your everyday refractory problems, your long range plans, or any emergency job.

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and dimensional accuracy of these castings are required.

Bottom pouring is usually employed. Any direct impingement of the metal on the mold surfaces must be avoided by appropriate guidance of flow. Cores are preferably made of sand, and must be properly blackened.

Preparation of the molds for pouring includes swabbing with a watery solution of waterglass and clay or graphite. This mold wash is applied after heating, and care must be taken to swab thoroughly all places where the temperature is the highest. Occasionally for small, simple pieces the wash may be omitted.

The main function of the wash is to prevent rapid heating, which might cause distortion of the mold. In general, one mold wash will last through 50 to 100 casting cycles. Prior to casting, the mold is cleaned by air blast and blackened by an acetylene torch.

The first few castings made while the mold is cool are discarded. Production proper is commenced when the mold has reached 425 F. It is important that this temperature be maintained on the mold face. Cooling is carried out by means of an air blast on the external front and rear surfaces.

Pouring is accomplished at the lowest possible temperature. Small, thin-walled pieces are cast at approximately 2550 F. and large, heavy-walled pieces at approximately 2375 to 2400 F. According to the size of the piece, the casting is removed within 15-30 sec. after pouring. Even so, considerable heat must be removed from the mold by cooling.

Where small castings of not over one lb. are involved, a casting is produced every six min.; larger castings are produced every 12 to 24 min. After ejection, the mold is cleaned with an air blast and blackened again to be ready for pouring. Fifty molds occupying a floor space of 2100 sq. ft. are in operation with a daily production of from 5.5 to 6 tons of castings.

—E. Englisch. *Die Giesserei*, Vol. 30, Aug. 1943, pp. 181-189; as abstracted in *Engineers' Digest*, (British) Vol. 5, Sept. 1944, pp. 280-282.

Porosity of Bronze Castings

Condensed from the "Journal of the Institute of Metals, London"

The authors have studied the distribution of porosity in bronze sand castings to determine the relative effects of shrinkage and of dissolved gases on the pressure tightness and strength of bronze castings.

The wide freezing range of bronzes precludes easy feeding and tends to cause widely dispersed small intercrystalline and interdendritic cavities. This porosity is due primarily to unfed freezing shrinkage, but a considerable amount of the porosity is tolerable in a casting, provided it is uniformly dispersed and not interconnected.

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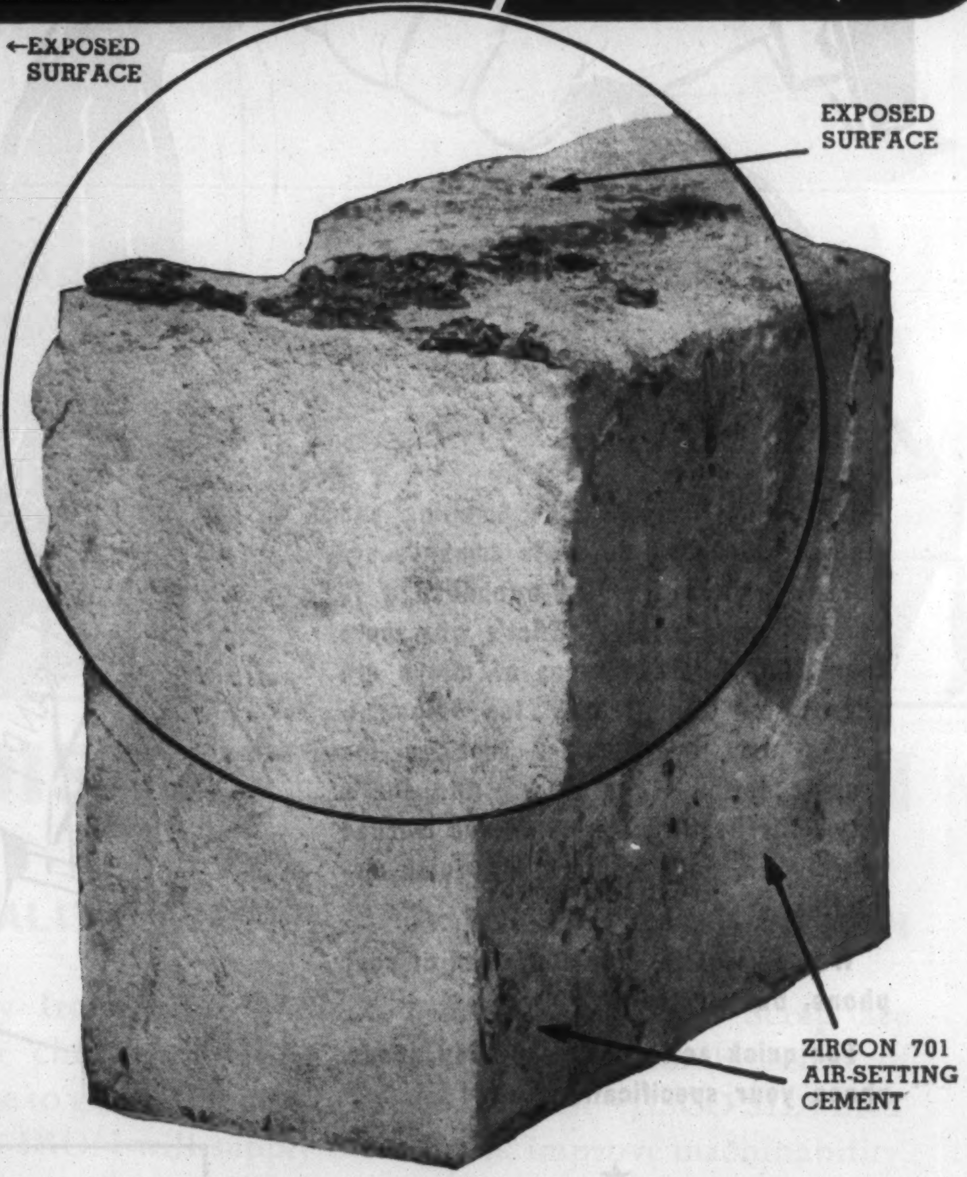
Section thru TAYLOR ZIRCON BRICK removed from hearth of aluminum re-melt furnace. 14,750,000 lbs. melted on this hearth. No penetration.



We think that these illustrations prove conclusively that, if the Refractory Industry ever developed a product which is unequalled, even uniquely fitted for one particular job, TAYLOR ZIRCON is certainly that product, when used for hearth construction in reverberatory type furnace for melting Aluminum.

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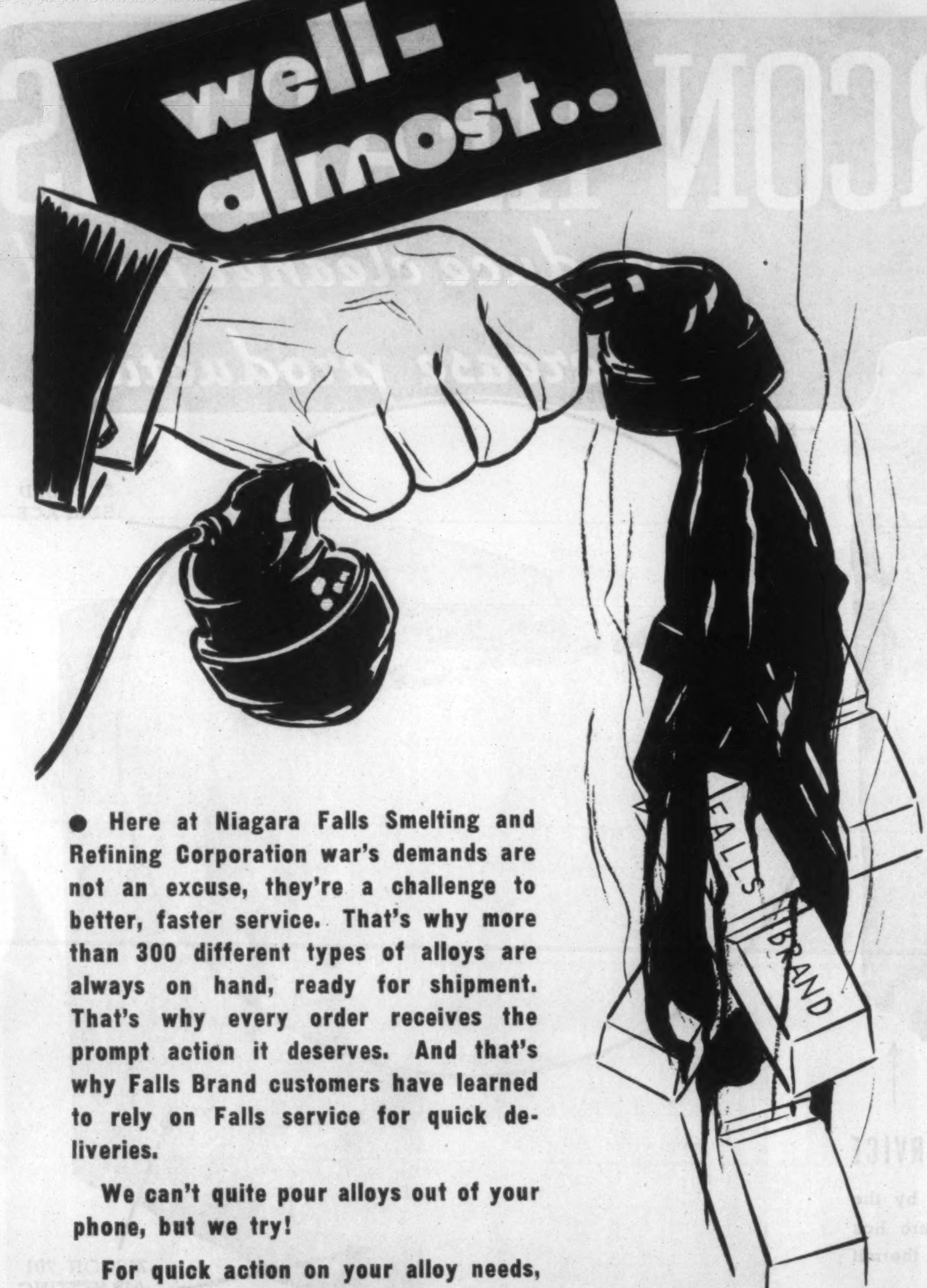

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Since the porosity tends to concentrate at areas such as ribs, section junctions and bosses that have been improperly fed, such concentrations may cause local weakness and leakage.

Dissolved gases, liberated during freezing, cause the appearance of larger amounts of similar porosity. Gas porosity sometimes has a beneficial effect in decreasing shrinkage porosity in improperly fed sections. This results in an increase in pressure tightness but a decrease in mechanical properties. As an example of this, the authors point out the beneficial effects of dissolved hydrogen in reducing shrinkage porosity in plain tin bronzes and low phosphorus tin bronzes.

Tin bronzes with higher phosphorus contents absorb hydrogen from moisture in sand molds, and this gas absorption is extremely effective in dispersing local concentration of porosity.

Copper-tin-zinc gun metals are less prone to local shrinkage porosity, but this condition may be serious in degassed metal. The presence of moderate amounts of gas in the metal causes an improvement in the distribution of the porosity and consequently results in improved properties. However, large amounts of gas cause excessive porosity with resultant deterioration in properties.

The leaded gun metals have very little tendency toward porosity when the metal is degassed. However, the presence of even small amounts of gas aggravates the effect of shrinkage in promoting local patches of porosity, and has a very bad effect on the properties of castings.

From a practical standpoint, the leaded gun metals are the best alloys for pressure castings of intricate shapes. These alloys give the best properties of all of the bronzes when their gas content is low. This condition may be attained more easily with the leaded bronzes than with the lead-free alloys by careful control of melting atmospheres, obviating the necessity of double or triple degassing operations required for the production of gas-free non-leaded alloys.

High-phosphorus tin bronzes can be degassed by blowing air through the charcoal-covered molten metal and subsequently flushing with dry nitrogen. Copper-tin-zinc alloys are the most difficult to cast without porosity.

Research has shown that mechanical properties of a casting cannot be correlated with those of separately-cast, properly fed test bars. Test bars give valuable information about the condition of the metal when both densities and mechanical properties are determined.

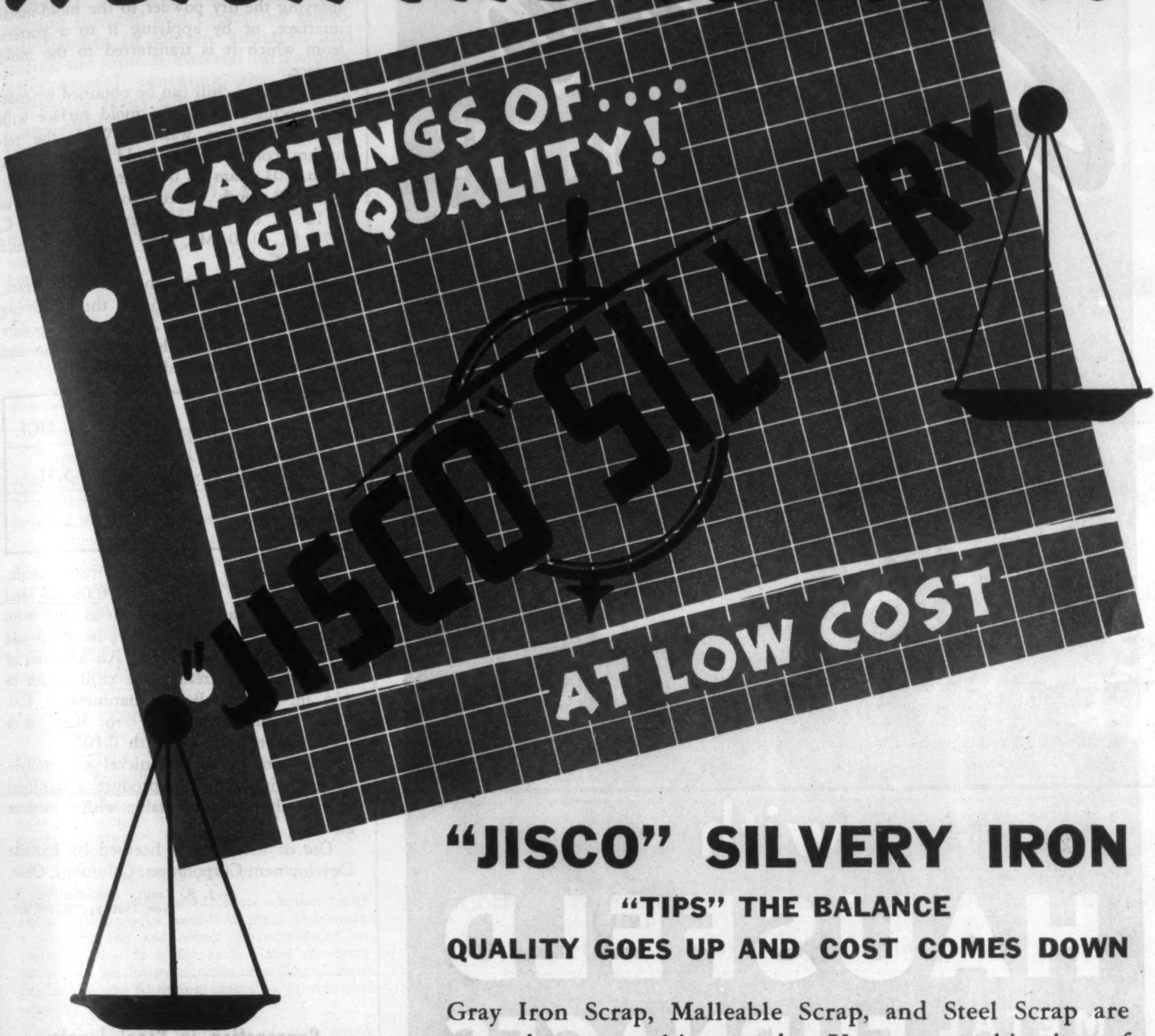
—W. A. Baker, F. C. Child & W. H. Glaisher. *J. Inst. Metals, London,* Vol. 70, 1944, Paper No. 971. 36 pp.

Chilled Iron with Tellurium

Condensed from "The Foundry"

Tellurium is such a potent chill-producing alloying element that very minute additions of it to cast iron will increase the chill depth, hardness and resistance to certain types of chemical attack.

WEIGH THE RESULTS!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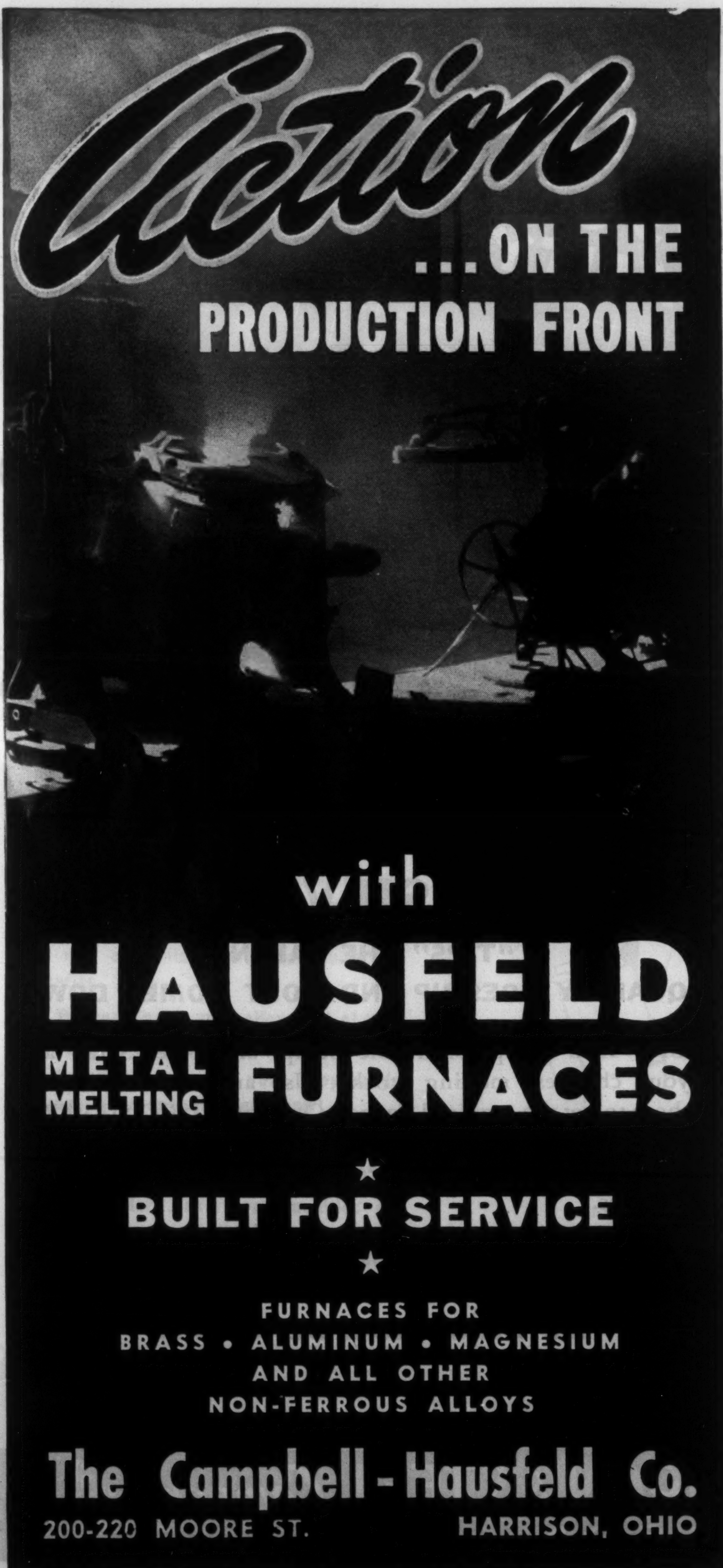
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Tellurium additions, such as solid metal or powder, usually range from 0.001 to 0.05%, but since its potency declines with time, it should be added just before pouring. It may also be added by painting or spraying the dry powder to the mold-metal interface, or by applying it to a pattern from which it is transferred to the mold surface.

A localized chill can be obtained by coating specific areas of the mold surface with tellurium-bearing washes. With the tellurium content of a mold wash varying from 0.01 gram to 0.05 gram per sq. in., the chill depth varied from 1/16 in. to 3/16 in. on an iron containing 3.20 C, 1.70 Si,, 0.50 Mn, 0.07 S, 0.20 P, and 0.50% Cr.

In a test for resistance to acid attack, Long and Krause reported the following losses in grams after 26 hours' exposure for an untreated, unchilled gray iron and for a tellurium-treated gray iron:

	2% H_2SO_4	2% HCl
Untreated, unchilled	4.16	5.51
Tellurium-treated	3.08	2.29

According to Smalley, an iron containing 3.1 C, 1.2 Si, 0.7 Mn, 0.095 S, and 0.2% P was cast against a metal chill with a resulting chill depth of ⅜-in. deep and a Brinell hardness of 415. An addition of 0.0025% Te increased the chill depth to 1½ in. and the Brinell hardness to 460. The hardness increased to 469 with 0.005% Te, and 477 with 0.10%.

Additions of copper, nickel and molybdenum with tellurium produce a hardness and toughness unobtainable with tellurium alone.

Use of tellurium is licensed by Battelle Development Corporation, Columbus, Ohio.

—**J. S. Crout.** *Foundry*, **Vol. 72, Nov. 1944, pp. 89, 218, 220.**

Segregation in Steel Ingots

Condensed from "Metals Technology"

Segregation effects in steel ingots involve a number of physical and chemical effects, and evidence upon certain aspects is rather incomplete. Certain underlying factors have been selected as significant.

The outflow of heat evolved in freezing determines the rate, and sometimes the direction, of crystal growth. Skeletal types of crystals, such as dendrites, show a tendency to grow faster along the original axis of growth than in other directions. The crystal nuclei possess a higher iron content, thus leaving an adjacent layer higher in impurities and lower in freezing point.

As a result of these concentration gradients, a rate of diffusion of mixing is introduced to limit the rate of freezing. This favors the dendritic form of crystal growth. The form can, however, be suppressed or at least very much changed in character by stirring vigorously enough to eliminate these concentration gradients.

A FEW FACTS ABOUT CORHART PRODUCTS

Corhart Electrocast Refractories are high-duty products manufactured by melting selected and controlled refractory batches in electric furnaces, and casting the molten material into molds. After careful annealing, the finished shapes are ready for shipment. Dense, high-melting refractories, they are especially designed for resistance to corrosive action.

PRODUCTS

CORHART STANDARD ELECTROCAST is a high-aluminous refractory.

CORHART ZED ELECTROCAST is Zirconia-bearing.

CORHART ELECTROPLAST is a high-temperature plastic refractory made from Standard Electrocast which has been ground and crushed. Especially designed for ramming. Furnished dry.

CORHART MORTAR is a high-quality cement for laying up Electrocast, clay brick, or any aluminous refractory.

CHARACTERISTICS OF STANDARD ELECTROCAST

POROSITY: Less than 0.5%—therefore virtually no absorption.

FUSION POINT: Cone 38 without any appreciable softening below that point.

HARDNESS: 8, Mineralogist's scale.

SPECIFIC GRAVITY: Blocks weigh approximately 183 lbs. per cu. ft.

COEFFICIENT OF EXPANSION: 0.000006 between room temperature and 900° C.

SPECIFIC HEAT: 0.25 cal. per gm. per °C. at 980° C.

THERMAL CONDUCTIVITY: 25 BTU per sq. ft. per hour for gradient of 1°F. per inch.

COMPOSITION: Standard Electrocast is of an aluminous crystalline nature.

CORROSION: Because of low porosity and inherent chemical make-up, Corhart products are highly resistant to corrosive action.

APPLICATIONS

Most heat processes present spots where a better refractory material is needed in order to provide a balanced unit and reduce the expense of repeated repairs. It is for such places of severe service that we invite inquiries regarding Corhart Products as the fortifying agents to provide the refractory "balance" desired.

The following is a partial list of applications for which Corhart Products are suggested:

ELECTROLYTIC CELLS — for production of Magnesium and other light metals.

SILICATE OF SODA FURNACES — sidewalls, bottoms, and breastwalls.

HEARTHS AND SMELTERS — for non-ferrous metals.

ALKALI AND BORAX MELTING FURNACES — fast-eroding portions.

GLASS FURNACES — the entire installation of flux walls and bottoms, breastwalls, ports, tuckstones, forehearths, recuperators, etc.

RECUPERATORS—tile, headers, separators, etc.

ENAMEL FRIT FURNACES — flux walls and bottom.

BRASS FURNACES — metal contact lining.

ELECTRIC FURNACES — linings for rocking type, and rammed linings of Electroplast for this and other types.

BOILERS — clinker line.

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Standard and Zed Electrocast are made in stock shapes and in many special shapes. The weight of individual pieces may run to 3500 pounds.

IF YOU NEED

A BETTER REFRACTORY—

● Corhart Electrocast Refractories are high-duty products which have proved considerably more effective than conventional refractories in certain severe services. If your processes contain spots where a better refractory is needed to provide a balanced unit and to reduce frequent repairs, Corhart Electrocast Refractories may possibly be the answer. The brief outline at the left gives some of the basic facts about our products. Further information will be gladly sent you on request.

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The high specific gravity of iron involves a large kinetic energy storage in vigorous stirring, and a large increase in ferrostatic pressure between the top and bottom ingot zones. There is also a very appreciable difference in specific gravity between the liquid metal and the solid crystallites. While the difference is not so large in terms of percentage, being only about 7%, the absolute difference is equal to about half the specific gravity of water, and allows for rather rapid settling of unattached dendrites.

There is evolution of gas resulting from the carbon-oxygen reaction in the iron solution. The gas-bubble formation is favored by a somewhat rough solid surface, while its repression is helped by increased ferrostatic pressure, the wide variation in reaction tendency with variable oxygen content of the liquid steel, and the importance of the stirring and blow hole-forming effects of the reaction.

—B. M. Larsen. *Metals Technology*, Vol. 11, Sept. 1944, pp. 13-36.

Whiteheart Malleable Iron Links

Condensed from "Foundry Trade Journal"

The foundry problems in the production of whiteheart malleable track links are similar to those of other whiteheart malleable castings, the main difference being that whereas a large percentage of ordinary malleable castings are usually machined, the track links are not machined at all, with the exception of reaming out the pinholes.

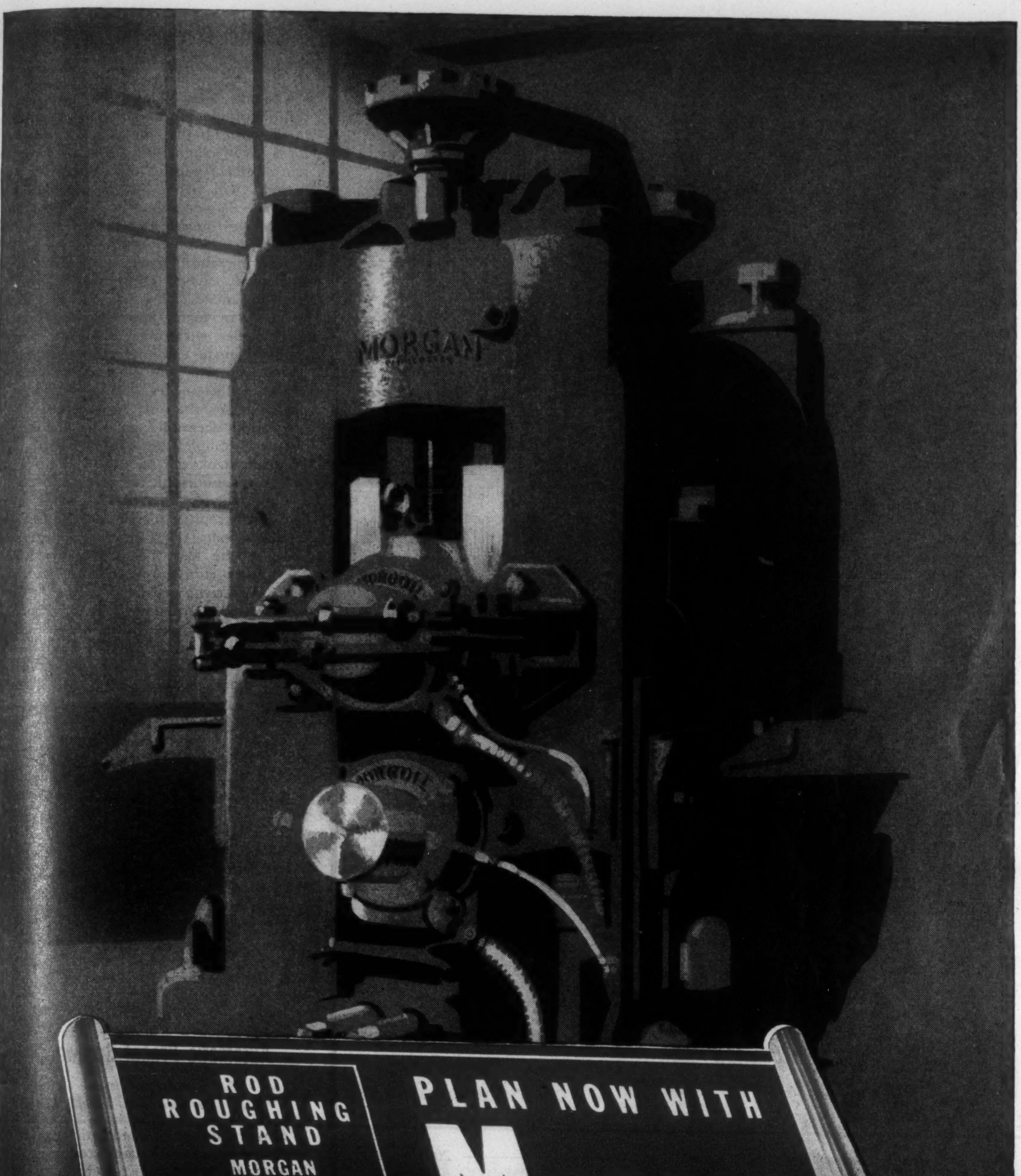
The metal is melted in cupolas that are equipped with stationary receivers. The metal temperature (uncorrected, measured with an optical pyrometer) taken at the receiver spout is between 1400 and 1430 C. (2550 and 2600 F.). The chemical composition of the molten metal is controlled within the following limits: 2.90 to 3.10 T.C.; 0.55 to 0.70 Si; 0.25 to 0.30 Mn; 0.16 to 0.20 S; and 0.10% max. P.

The annealing is carried out at a temperature of 980 C. (1800 F.) and usually maintained for 80 to 100 hrs. at this temperature, according to the section of the castings. The ore ratio is varied between 1 to 5 and 1 to 8, again, according to casting section.

The wearing properties and resistance to heavy loads of whiteheart malleable cast iron can be greatly improved by suitable hardening and, in some cases, a subsequent simple tempering operation. It is, of course, very necessary to have thoroughly annealed castings before carrying out the hardening operation, as under-annealing is liable to lead to brittleness on quenching.

All the track link castings in the earlier types received a further treatment after the mealleabilizing operation, namely, a cyanide hardening, producing a fairly hard surface of about 0.015-in. thickness with a toughened core. This operation was, however, discontinued in favor of a straightforward oil-hardening process, the parts being heated throughout the section as quickly as possible in salt bath furnaces to 780 C. (1440 F.), then quenched direct in mineral oil.

—G. R. Webster. *Foundry Trade J.*, Vol. 74, Oct. 5, 1944, pp. 87-91; Oct. 12, pp. 109-114; Oct. 19, pp. 139-142.



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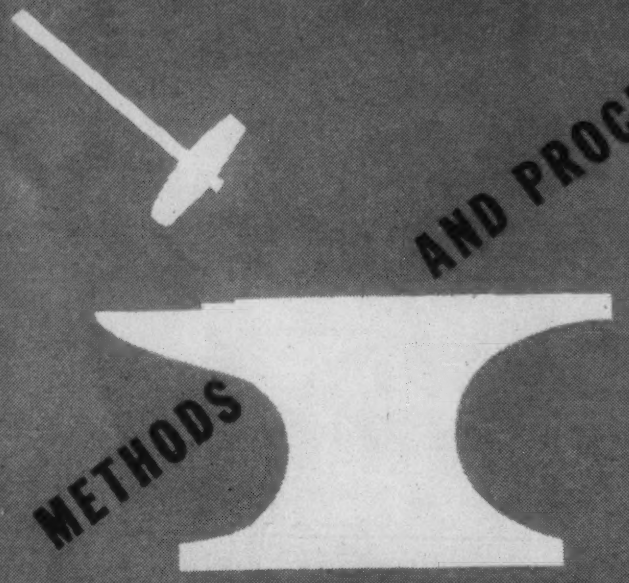

METHODS AND PROCESSES

FABRICATION and TREATMENT

Machining, forging, forming, heat treating and heating, welding and joining, cleaning and finishing of solid materials. Methods, equipment, auxiliaries and control instruments for processing metals and nonmetals and for product fabrication.

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Counter Current on Zinc Anodes

Condensed from "Metal Finishing"

Cyanide zinc plating requires careful control of the concentration of zinc metal in the bath. If the zinc content is too low, for a given cyanide concentration, the current efficiency will be low; if it is too high, deposits will be dull and irregular. The tendency of zinc anodes to dissolve chemically makes the maintenance of the correct zinc concentration difficult.

Alloying the anodes with mercury or aluminum prevents chemical attack of the zinc, but anodes containing mercury cannot be used in many applications. Alloying zinc anodes with magnesium or calcium controls anode efficiency during operation of the bath, but does not prevent chemical attack of the anodes during idle periods.

Heretofore, the only certain method for preventing chemical attack of the anodes has been complete removal of all of them from the tank during idle periods. This involves considerable labor and time for large installations.

A small counter-current applied between a zinc anode (as cathode) and a steel plate in the bath (as anode) is highly effective in eliminating chemical attack of zinc. A current density of 0.20 amp. per sq. ft. completely prevents zinc from going into solution. This is true even when zinc is in contact with steel anode baskets.

A 2-volt storage battery, kept charged with a small rectifier, suffices as a current source. The total current required for a 1000-gal. tank is approximately 1¼ amp. More than 2 volts is not desirable, because zinc is then slowly plated onto the anodes.

A light gage steel sheet having at least half the area of the anodes (3 to 6 sq. ft. for a 1000-gal. tank) is hung on the cathode bus bar when the tank is not in operation and is made anodic with the 2-volt battery. Alternatively, the tank itself, if it is of plain steel, may be used as an anode. The steel sheet is preferred.

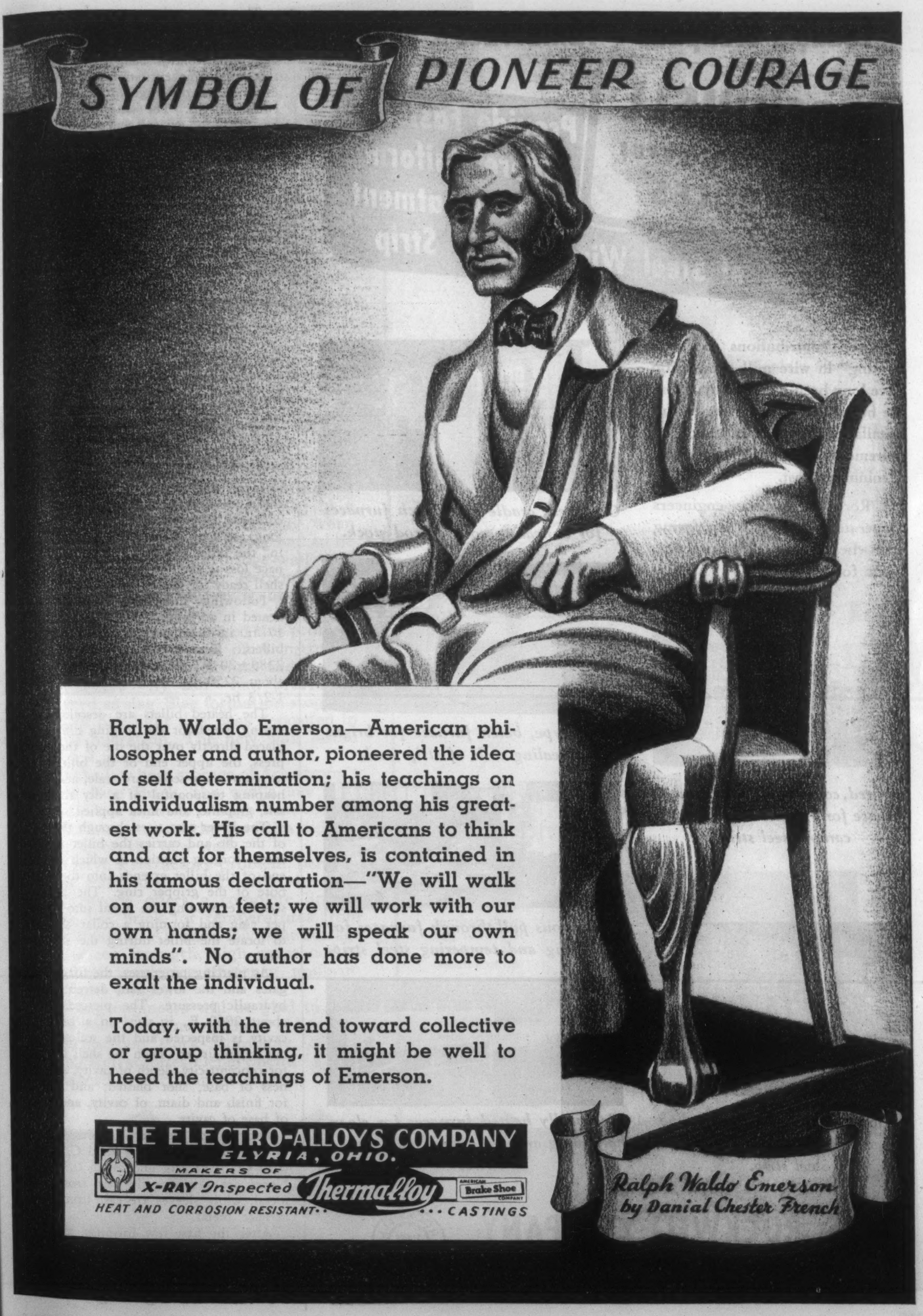
—R. O. Hull. *Metal Finishing*, Vol. 42, Sept. 1944, pp. 545-546.

Automatic Preset Screwdown

Condensed from
"Blast Furnace and Steel Plant"

A new method of automatic control has been developed to obtain greater accuracy in the adjustment of screw-down positions and to avoid the objectionable features apparent in some existing installations. Standard, well-known devices, such as the selsyn, the radio vacuum tube, and the amplidyne, make up the essential elements of this new control.

The fundamental idea is based on the use of the output voltage of a coarse and vernier selsyn system consisting of a mill unit driven by the screw-down motors, and a similar unit adjusted to some pre-set position. Because the selsyns are not required to develop any turning force, the difference between their output voltages is an accurate indication of the angular displacement between them.


SYMBOL OF PIONEER COURAGE
Ralph Waldo Emerson by Danial Chester French

Ralph Waldo Emerson—American philosopher and author, pioneered the idea of self determination; his teachings on individualism number among his greatest work. His call to Americans to think and act for themselves, is contained in his famous declaration—"We will walk on our own feet; we will work with our own hands; we will speak our own minds". No author has done more to exalt the individual.

Today, with the trend toward collective or group thinking, it might be well to heed the teachings of Emerson.

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MAKERS OF
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HEAT AND CORROSION RESISTANT... ...CASTINGS

Today's Weapons—Tomorrow's Tools

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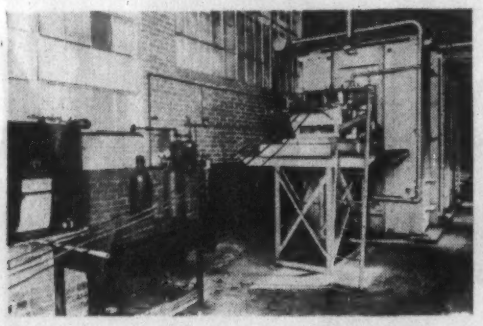
Batch or Continuous
FURNACES

Provide Faster—
More Uniform
Heat Treatment
of Steel Wire · Rod · Strip

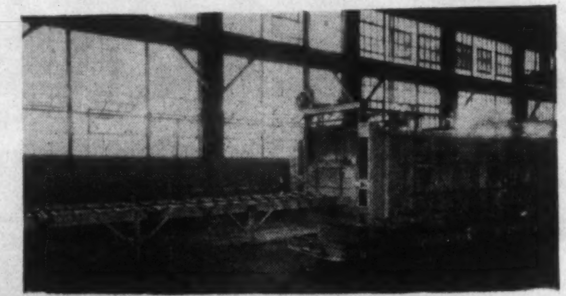
Rockwell contributions to "heat treating" in wire mill production have long been outstanding. Here are but a few of many successful installations that meet exact requirements of heating uniformity at minimum cost.

Let Rockwell furnace engineers cooperate with you in improving your heat processing practice. Write for bulletins.

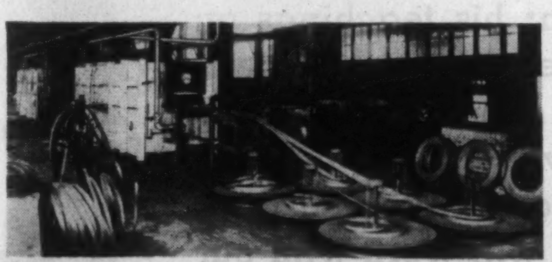
Gas fired, cradle type batch furnaces for annealing coils of rod stock.



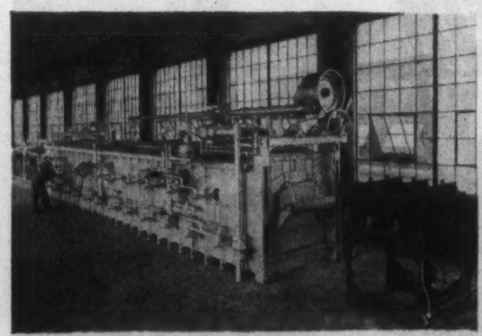
Oil fired, continuous, pull-through furnace for bright annealing high carbon steel strip.



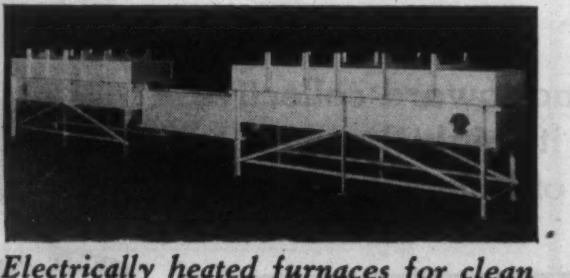
Cover type, batch furnace for bright annealing coils of strip steel.



Continuous pull-through furnaces for hardening and tempering steel strip.



Gas fired, continuous catenary type furnace for annealing stainless steel strip.



Electrically heated furnaces for clean hardening and tempering small gauge wire.

W. S. ROCKWELL COMPANY
54 CHURCH STREET · NEW YORK 7, N. Y.
ROCKWELL SINCE 1888 BUILT
FURNACES · QUENCHING EQUIPMENT · OVENS · DRYERS · BURNERS · VALVES

This output voltage, no matter how small, is sufficient to control the grid circuit of a vacuum-tube amplifier, which excites an amplidyne control field. The polarity of this amplidyne excitation depends on the direction of the angular displacement between selsyns. The amplidyne may then be used to excite generators supplying power to the screw-down motors and cause the mill unit selsyns to move toward correspondence with the pre-set selsyn unit.

The control equipment includes an electronic rectifying and amplifying panel; roll opening selector, incorporating coarse and vernier selsyn units; roll opening limit switch; pass transfer relay; roll diameter selector, which is a differential selsyn unit; selsyn-tachometer mill unit; and a pass selector unit.

—R. E. Marrs. *Blast Furnace & Steel Plant,* Vol. 32, Oct. 1944, pp. 1191-1197.

One-Shot Forging

Condensed from "Steel"

In the manufacture of 155-mm. shell by the J. I. Case Co., Racine, Wis., round-cornered, 5½-in. square billets, 14¾ in. long, are used. The corner radius is 1-9/16 in., the billet weighs 119±½ lb., the furnace loss is about 1½ lb., and the finished shell ready for loading weighs 78 lb.

Following inspection, the billets are heated in an oil-fired rotary-hearth furnace, 17 ft. in diam., with a capacity of 222 billets. Temperature is maintained at 2280±20 F., the billet on removal being about 2250 F. Minimum heating time is 1-2/3 hr.

The heated billets are descaled by upsetting, sized for the forging die by rolls, placed directly over the die of the forging press, the upper end of the billet scraped to remove any secondary scale, and about a heaping teaspoonful of a dry mixture of salt, graphite, and mica applied.

The lower ram rises through the bottom of the die and carries the billet up to the initial forging position in which the upper end of the billet extends into the counterbore of the gripper ring. The punch descends, expanding the metal into the gripper ring and forming a collar that serves to locate the billet during the subsequent pierce.

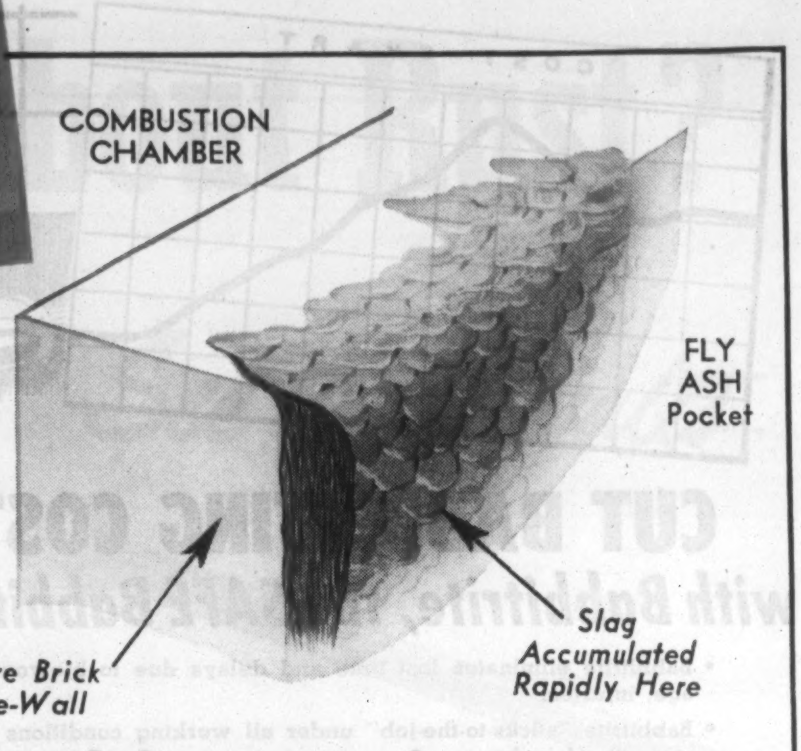
As piercing progresses, the forging elongates and the lower ram descends against hydraulic pressure. The pierced shell, at about 2060 F., is sized in a press. The cavity is inspected and the scale is blown out by an air jet. Then the shell is checked for concentricity, depth of cavity, and thickness of base; shot blasted; and inspected for finish and diam. of cavity, and contour of base of cavity.

Punches for the piercing press are made of cast-iron containing 3 total C, 1.50 Ni, 0.50 Cr, 0.50 Mo, and about 0.70% Mn. Noses are centrifugally cast from cupola metal, while sleeves are cast from electric-furnace metal.

After the first few forgings, the punch heat checks and grows. This growth makes regrinding possible. Average production with a new punch is 700. Another 700 can be made after regrinding.

Have you a furnace problem like this?

To prevent slag formation on the bridge wall and adjacent walls of an incinerator


COMBUSTION CHAMBER
FLY ASH Pocket
All Fire Brick Bridge-Wall
Slag Accumulated Rapidly Here

Here's how it was solved in one instance:

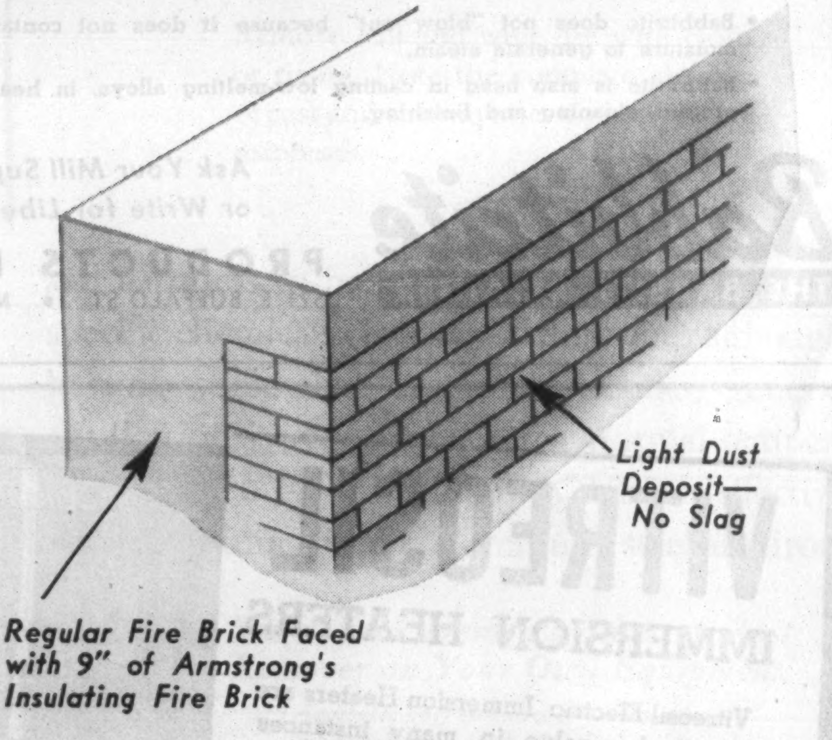
Armstrong's engineers were asked to seek a solution to the problem of preventing the rapid formation of heavy, hard slag in a large city's incinerator. Every Sunday, when the plant was shut down, the slag had to be chipped off the fire brick bridge-wall with crowbars—at great expense. Removing the slag weakened the wall, so it had to be rebuilt every few months.

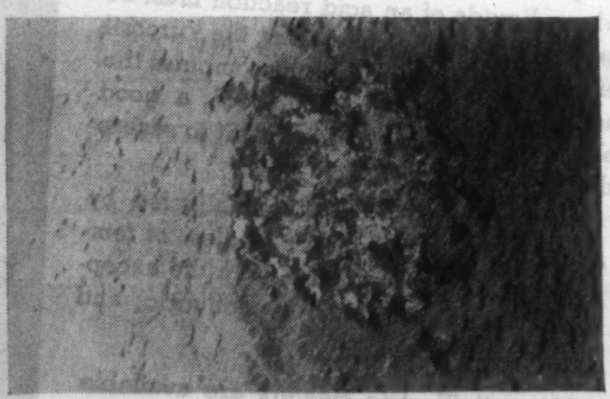
Armstrong's engineers solved this problem by building a 9" thickness of Armstrong's A-26 Insulating Fire Brick into the face of the wall where "fly ash" had previously accumulated as slag. Slag formation stopped. Only ½" of fine light dust was deposited in months of operation. The new wall lasted more than 4 years.

Due to the low heat storage of Armstrong's Insulating Fire Brick, the wall's low heat content did not provide enough heat to fuse the ash striking it, and the particles did not form as slag on the new wall.

If you have a refractory problem, perhaps insulating refractories will provide the solution. Armstrong offers a complete line of insulating fire brick for temperatures from 1600° to 2600° F. All have low heat storage and also great strength, high resistance to spalling, high insulating efficiency, uniformity, and light weight.

Armstrong engineers will be glad to help you solve your problem—without obligation. Write Armstrong Cork Company, Insulating Refractories Department, 5501 Concord Street, Lancaster, Pa.

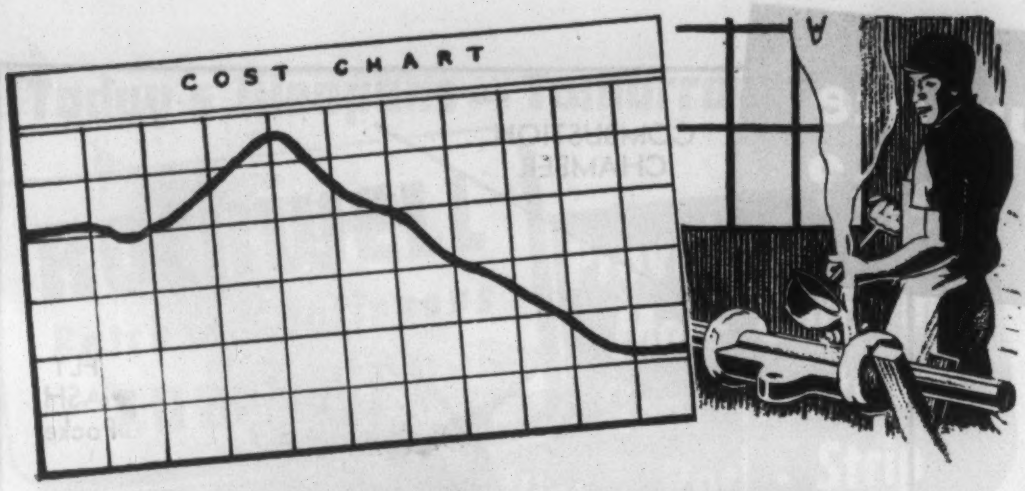

Light Dust Deposit—No Slag
Regular Fire Brick Faced with 9" of Armstrong's Insulating Fire Brick



Actual photograph showing surface of wall after months of operation. Dust has been brushed off insulating fire brick (center).

Armstrong's A-18
Armstrong's A-20
Armstrong's A-23
Armstrong's A-25
Armstrong's A-26

ARMSTRONG'S INSULATING REFRACTORIES



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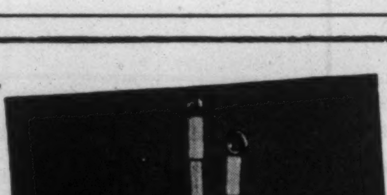
VITREOSIL

IMMERSION HEATERS



Vitreosil Electric Immersion Heaters are of particular value in many instances where liquids of an acid reaction must be heated. For such applications, the Vitreosil envelope of the heating unit combines the advantages of being acid-proof, a good electrical insulator, and resistant to severe thermal shock.

Vitreosil (99.8% SiO_2) is unaffected by all halogens and acids, regardless of temperature or concentration, with the exception of fluorine and hydrofluoric and phosphoric acids.

Vitreosil Electric Heaters are available in lengths ranging from 10 to 30 inches with k.w. ratings of .25 to 5.0.

Write for full details and quotations on Vitreosil Electric Immersion Heaters.

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REG'D TRADE MARK

THE THERMAL SYNDICATE, LTD.
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The die lining and gripper ring are of the same composition as the punches. Cracking of the liners is minimized by making four longitudinal saw cuts 1/32-in. deep and 90 degrees apart around the outer circumference. One liner produces 800 to 1200 shells.

—A. F. Macconochie. *Steel*, Vol. 115, Oct. 30, 1944, pp. 74-77, 126.

Reappraisal of Electrogalvanizing

Condensed from "Wire and Wire Products"

Corrosion tests show that the superior life of electrogalvanized wire, as compared to hot-dipped, is largely a result of the uniformity of the coating thickness. Samples taken every 100 ft. along a mile of wire showed less than 1% variation in thickness. Such uniformity is rare in hot-dipped galvanizing. Wire becomes uniformly coated around its circumference even though anodes are placed only on one side of the wire, because of the tendency of the wire to twist while traveling through the tank.

Zinc metal losses in electrogalvanizing are very low. Dragout loss amounts to about 0.08% of the zinc consumed, and losses due to plating on contacts, etc. are such that the estimated total losses are about 0.2%. Anode losses are negligible. Utilization of zinc is well over 99%.

The application of heavy coatings (2 or 3 oz.) is somewhat more difficult than the deposition of light coatings (1 oz.), in that the solution must be filtered clean, the pH properly adjusted, etc. If these factors are properly controlled, heavy deposits merely require adjustment of the line speed and current.

One of the most interesting applications of electrogalvanizing has been the plating of larger sizes of wire prior to drawing to smaller sizes. The coating is not at all damaged by drawing, and is reduced in direct proportion to the reduction in the wire.

It is more economical to plate the wire in large sizes, and draw it down afterwards, than to galvanize the long length of fine wire. Drawing after galvanizing gives a harder, stronger wire. The zinc is a good die lubricant.

—E. H. Lyons, Jr. *Wire & Wire Products*, Vol. 19, Oct. 1944, pp. 646-648, 732-733.

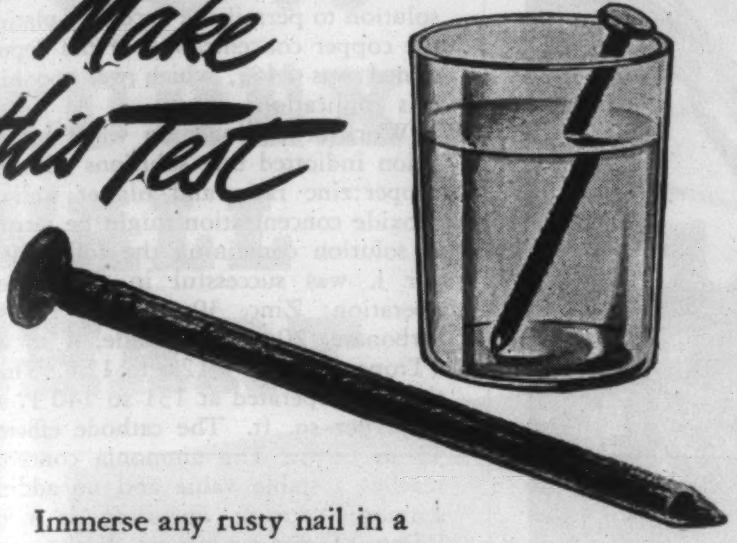
Brass Plating Steel Cartridge Cases

Condensed from "Journal of the Electrodepositors' Technical Society"

The mechanical plant for automatic plating of 600 sq. ft. of steel cartridge cases per hr. with 0.0003 in. of 70:30 brass shows several new features. In order to avoid making the plant unduly large, it was necessary to develop a brass plating solution that could be operated at a minimum of 18 amp. per sq. ft. at good efficiency.

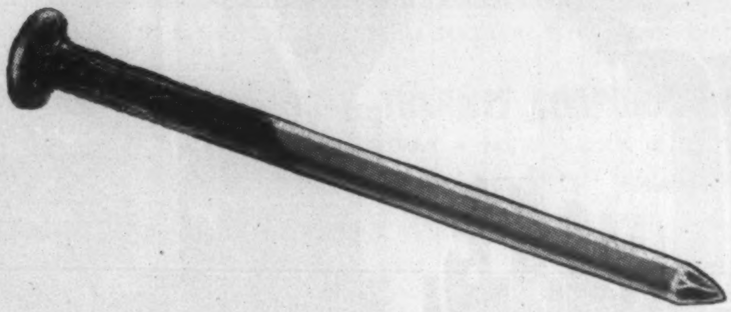
What to do about Rust?

Make this Test



Immerse any rusty nail in a small quantity of Cities Service Rust Remover. If badly rusted, allow to remain for several minutes. You can actually see the rust dissolve.

See the Results



Remove nail and wipe dry with cloth or tissue. Note the complete absence of rust and the way the original surface reappears.

CITIES SERVICE RUST REMOVER has been tested for four years throughout a small, highly industrialized area in the East, where it has earned a unique reputation for performance. RUST REMOVER is a clean, clear liquid, practically odorless, non-inflammable, easily applied, and harmless to handle by those not allergic to specific chemicals. It is fast-acting, and, although heating somewhat accelerates results, general application is recommended at normal temperature (60°-90°F.). RUST REMOVER is effective on chromium, copper, aluminum, steel and iron.

See a Free Demonstration of Rust Remover on Your Own Equipment.

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Gentlemen: I'd like to test RUST REMOVER on my own equipment FREE OF CHARGE. Send me details.

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Company..

Address...

City.............................. State.............................

5 Big Advantages

1. Non-Inflammable
2. Harmless to Normal Skin
3. Makes Metals Chemically Clean
4. Removes Rust by Chemical Action
5. Free from Muriatic, Sulphuric, Nitric and Oxalic Acids or Cyanide.

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After V-Day, just as now, core quality and speed of production will be the chief factors in determining competitive standing. Whether Gray Iron, Magnesium or Aluminum, the future quality standard required of castings will demand better cores from which to make them. And core quality can be no better than the oven that bakes them.

ROSS Core Ovens, in a range of sizes and types for all requirements, are designed with the exclusive ROSS heating and circulating system that positively insures greater Uniformity, Elimination of Rejects, Increased Output in Less Time and in Less Space. The best proof of the remarkable performance of ROSS OVENS is the list of

Prominent Users:

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The ROSS system of heating and circulation might be applied to improving your present oven. Why not ask us about this? No obligation.

ROSS SYSTEMS
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ENGINEERING CORP.
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CHICAGO 6—201 N. WELLS ST. DETROIT 3—12953 GREELEY AVE.
ROSS ENGINEERING OF CANADA LIMITED—DOMINION SQUARE BUILDING—MONTREAL

Conventional solutions are operated at only 3 to 6 amp. per sq. ft. Conventional yellow brass solutions investigated had the property in common that with increase in current density and with change of those conditions which increased the cathode efficiency, the copper content of the brass increased. On increasing the current density and cathode efficiency of a conventional solution to permit the necessary plating rate, the copper concentration of the deposit obtained was 84%, which was too high for this application.

Work of Oplinger on white brass deposition indicated that solutions with a lower copper:zinc ratio and higher sodium hydroxide concentration might be satisfactory. A solution containing the following in g. per l. was successful in the large scale operation: Zinc, 30; copper, 15; sodium carbonate, 20; free cyanide, 4 to 8; pH, (Tropaeolin "O") 12.6 to 12.8. This solution was operated at 131 to 140 F. and 20 amp. per sq. ft. The cathode efficiency is 55 to 60%. The ammonia concentration reaches a stable value and no addition of ammonia during operation is necessary. Effects of changing some of the operating variables are as follows: Increase in total metal concentration increases the cathode efficiency; decrease in copper:zinc ratio, and increase in sodium hydroxide concentration in the solution decreases the copper content of the deposit.

Anodes of 70:30 brass were used. The solution has been stable and operation satisfactory over a period in which the metal content of the tank (750 lb.) has been removed and replaced three times by anode corrosion.

—John Kronsbein & Alan Smart.
J. Electrodepositors' Tech. Soc.,
Vol. 19, 1944, pp. 107-122.

Electrolytic Alloy Deposits

Condensed from
"Zeitschrift für Elektrochemie"

Electrolytic deposition of an alloy was applied mainly in the case of brass and of gold alloys. Little was known with regard to their structure and the relation of the latter to the diagram of state; therefore, an investigation was made of structure and properties of electrolytically deposited alloys of two components which, according to their diagrams of state, have only a very slight mutual solubility at room temperature. The silver-rich, silver-lead alloys were used for this investigation by microscope, X-rays, electrical resistance and hardness measurements.

In the simultaneous electrolytic deposition of silver and lead, a solid solution phase is formed, contrary to the diagram, even at lead contents of over 10%, which has the lattice of silver. This phase has, up to 7% Pb, an almost uniform, little varying composition even if the deposited layer is very thick. If the lead content is higher, however, the composition varies for the thicker layers. This is indicated in the etched sections by layers of more or less easy etchability.

Lead concentration has a strong influence on lattice constant and electrical resistance but not on hardness. Hardness is deter-

New

MUREX WALL CHART

A helpful guide to selecting the right Electrode for the job

This new chart, just off the press, contains a complete list of Murex Electrodes divided into four groups for quick reference; mild steel, special steels, stainless steels and hard surfacing. Electrodes are described according to AWS-ASTM class. Color identification, recommended current strengths, polarity, and physical properties are also given. In addition, there are brief descriptions of the electrodes' general characteristics and applications.

The chart is 24" x 37", printed in four colors.

Copies will be sent free to those who request them on their company letterhead.

METAL & THERMIT CORPORATION
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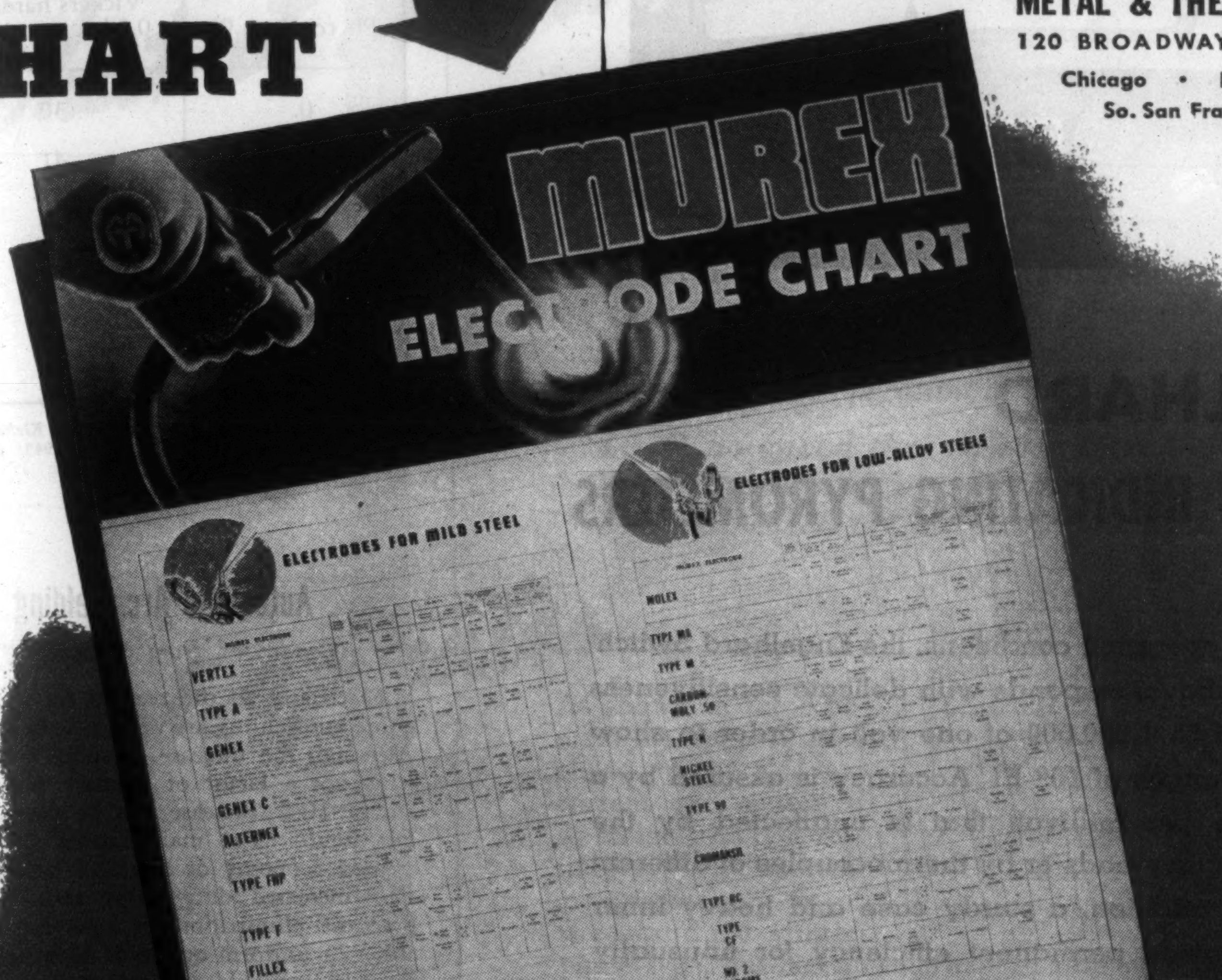
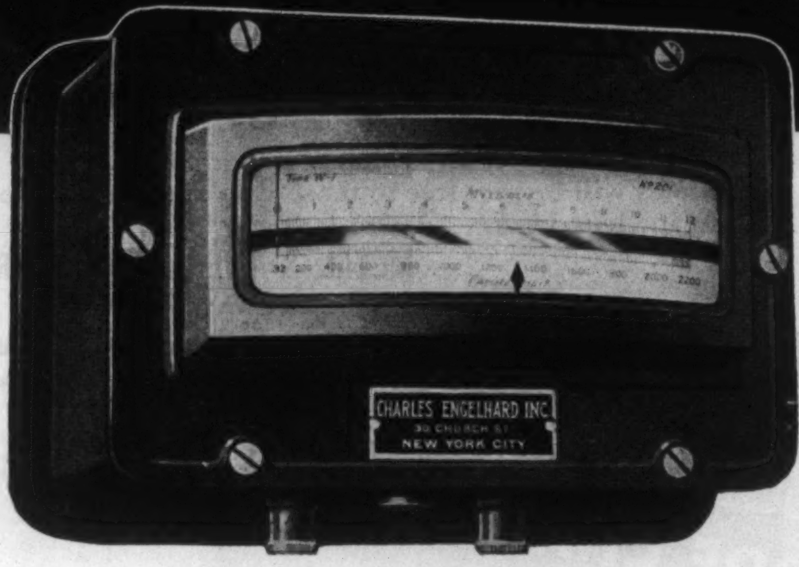

MUREX
ELECTRODE CHART
ELECTRODES FOR MILD STEEL
VERTEX
TYPE A
GENEX
GENEX C
ALTERNEX
TYPE FHP
TYPE F
FILLEX
ELECTRODES FOR LOW-ALLOY STEELS
MOLEX
TYPE MA
TYPE M
CARBON-MOLY .50
TYPE N
NICKEL STEEL
TYPE 90
CHROMANSIL
TYPE HC
TYPE SS
NO. 2 CHROME
ELECTRODES FOR STAINLESS STEEL
ELECTRODES FOR HARD SURFACING
HARDEX

MUREX *Electrodes*

Unconditional Sensitivity!



ENGELHARD

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Despite severe operating conditions, the Engelhard Switchboard model (above) responds with delicate sensitiveness to variations of 55/1,000,000 of one volt in order to show temperature changes of 10° F! Accuracy is assured by a high resistance per millivolt that is unaffected by the length of connecting leads or by thermocouples of different resistances. In addition, a sturdy case and heavy inner construction provide permanent efficiency for unusually difficult services.

Readings by direct deflection are made simply and *instantaneously* in either millivolts or temperatures. This model can be calibrated with two ranges for one type of thermocouple, or for two types of thermocouples in any combination desired. It is provided with a zero adjustment device to allow setting for ambient temperature variations.

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CHARLES ENGELHARD, INCORPORATED
90 CHESTNUT ST., NEWARK, NEW JERSEY

mined by the particular structures of the electrolytic silver-lead alloys, which are caused mainly by the extraordinary fineness of grain. Under heating, the electrolytic alloys demix heterogeneously, and that much faster than pre-deformed recrystallized specimens with equal or higher lead content.

The demixing velocity of the alloys increases little with increasing lead content, and is determined not so much by the atomic lead concentration in the solid solution as by the strongly pronounced mosaic structure even at low lead content.

The Vickers hardness of silver-rich silver-lead alloys after quenching from 650 C. was found to be:

Pb content, %	Vickers hardness, 0.5 kg. per sq. mm.
0.	30
0.09	41
2.95	41
4.9	38
6.8	40
10.3	34

—E. Raub & A. Engel. *Z. Elektrochemie,* Vol. 49, Feb. 1943, pp. 89-97.

Automatic Arc Welding

Condensed from "Machinery"

Practically all the reasons for using machine arc welding are tied up with economy. Although the increase in speed is obvious, it is not a factor of primary importance, and a 10% increase can be considered a fair figure. The main factors in the increased economy of machine welding are: (1) increased duty factor as a result of practical elimination of operator fatigue; and (2) uniform quality if adequate equipment is available and electrodes and joint preparation are also uniform.

Automatic welding heads to provide automatic maintenance of the arc length are available for the following types of welding: (1) metallic arc, using bare or lightly coated electrodes; (2) shielded arc with coiled electrodes; (3) shielded arc with short electrodes; (4) carbon arc; (5) inert gas shielded arc without or with filler; and (6) atomic hydrogen.

The arc voltage is used to determine the proper position of the welding electrode or the rate of feed. Electronic tube control panels regulate the speed and direction of the rotation of the electrode driving motor.

In order to obtain the maximum benefit from machine welding, it is essential (1) to have a sufficient volume of production to pay for the fixed charges on the automatic welding heads and the fixtures and handling devices that must be used; (2) that the contour and fit-up of each piece must be the same to avoid adjustments; and (3) fixtures and handling facilities must be engineered as a part of the project.

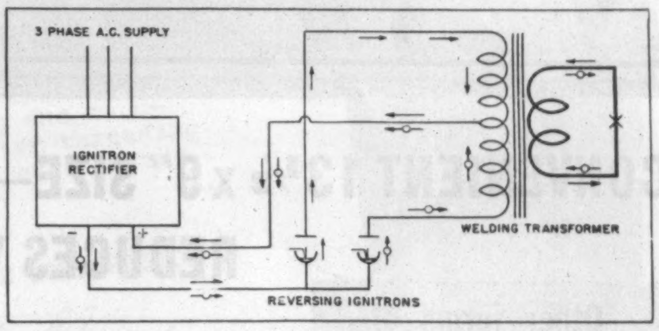
"THREE-PHASE" resistance welding

what it means

Spot, seam or flash welding steel in heavy gauges can now be accomplished on a balanced three phase load. This revolutionary achievement in power efficiency overcomes many limitations encountered with a.c. single phase welders. These are: disturbance to the usual three-phase supply by the unbalanced load, the heavy reactive load which results in low power factor, and the high power demand caused by secondary resistance. The Sciaky "THREE-PHASE" system *reduces cost of power installation and cost of operation* by providing:

1. ***A balanced three-phase load***
2. ***Operation at near unity power factor (less KVA)***
3. ***Decreased actual power demand (less KW)***

how it operates



As shown in the schematic diagram, all three phases of the a.c. line current are converted by an ignitron type rectifier to d.c. The welding transformer is of the standard single-phase type, but has a center-tapped primary. The d.c. current is fed to the primary through a system of two ignitron tubes which fire alternately and allow the current to flow through only one winding at a time. Thus, while the direction of the current supplied by the rectifier is always the same, since it flows in only one winding at a time during successive impulses, *it will flow in opposite directions in the primary.* Therefore, the induced welding current in the secondary is a continuous alternating impulse of low frequency . . . *of ideal wave shape and magnitude.*

send for booklet

Bulletin 204-A describing fully the operation of the Sciaky "THREE PHASE" will be gladly sent on request.

SCIAKY BROS.

Manufacturers of a Complete Line of AC and DC Electric Resistance Welding Machines
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In France: Sciaky S. A., 13, 15 Rue Charles Fournier, Paris

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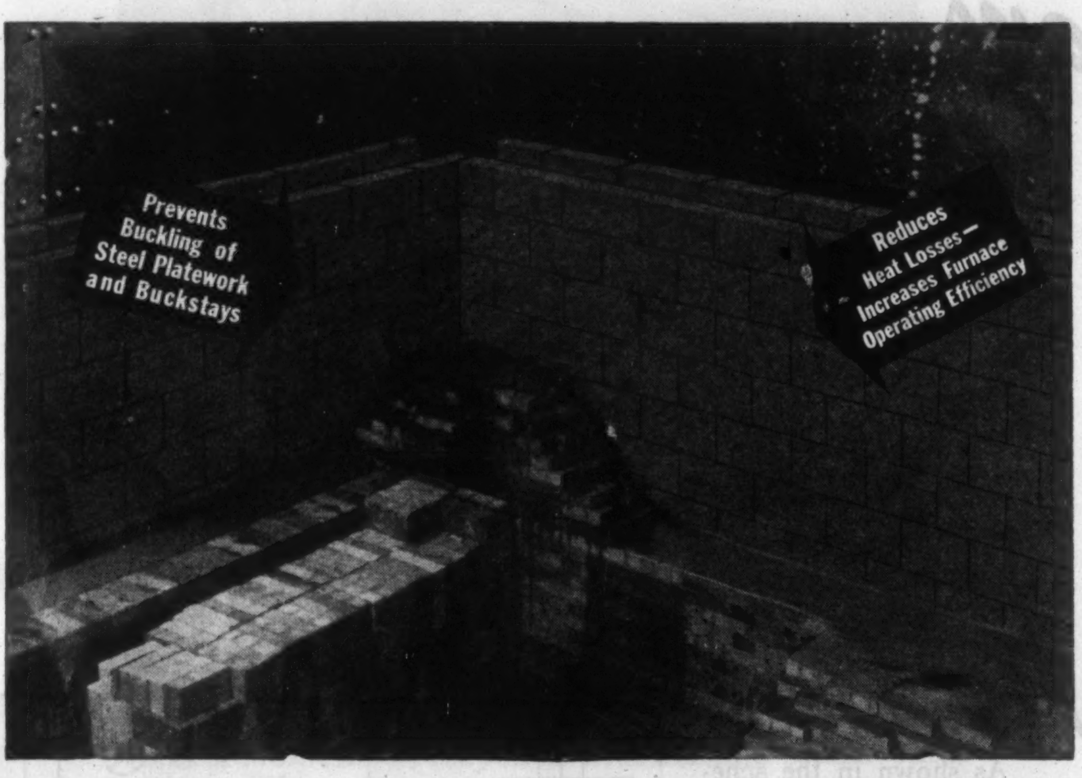
LIGHTWEIGHT INSULATING BRICK

does "Double Duty"

in Furnace Walls



Prevents Buckling of Steel Platework and Buckstays
Reduces Heat Losses — Increases Furnace Operating Efficiency

CONVENIENT 13½ x 9" SIZE—EASY TO HANDLE

REDUCES WALL JOINTS 65%

Protects furnace steelwork and plating from excessive heat with a strong resilient cushion which absorbs expansion stresses.

KEEPS HEAT INSIDE FURNACE WALLS

Excellent insulation,— a 4½ inch thickness being equivalent in heat flow resistance to more than 29 inches of fire brick.

Find out how quickly THERM-O-FLAKE Brick will pay back their cost in reduced furnace heat losses. For specific data, indicate type of furnace and approx. operating temperatures in writing to:

Other forms of THERM-O-FLAKE INSULATION

Coating — Seals and Insulates all types of furnace walls. Highly plastic, works and spreads easily.

Blocks — Highly efficient insulation where larger size units may be required.

Concrete — Monolithic castable insulation with high insulating value.

Granules — Loose-fill, efficient insulation, weighs only 6 pounds per cubic foot.

Illinois Clay Products Company
JOLIET, ILLINOIS

Therm-O-flake BRICK

FOR HOT FACE TEMPERATURES UP TO 2000° F.

It should be possible to maintain the speed within ±5% in all cases and to ±1% on critical jobs. This uniform speed must be maintained from second to second to avoid non-uniform welding with resultant porosity, inclusions, etc. The electronic control now available will hold the speed to a 1% tolerance even in the presence of considerable line voltage variation.

Most work must be clamped rigidly to prevent warping and buckling. Chill bars may be used to obtain a uniform controlled heat flow. A large mass will chill itself, but stock 3/16 in. and under usually requires a chill bar, especially if the welding is rapid so the rate of heat input is high.

—R. F. Wyer. *Machinery*, Vol. 51, Nov. 1944, pp. 148-154.

High Frequency Dielectric Heating

Condensed from a Paper of the National Electronics Conference

In order to heat uniformly the complete mass of that class of low thermal conductivity materials usually considered as electrical and thermal insulators, a type of high frequency electric heating known as dielectric heating is used. In this new industrial tool, the heating effect is produced by placing the material to be heated between the plates of a condenser of an oscillating circuit.

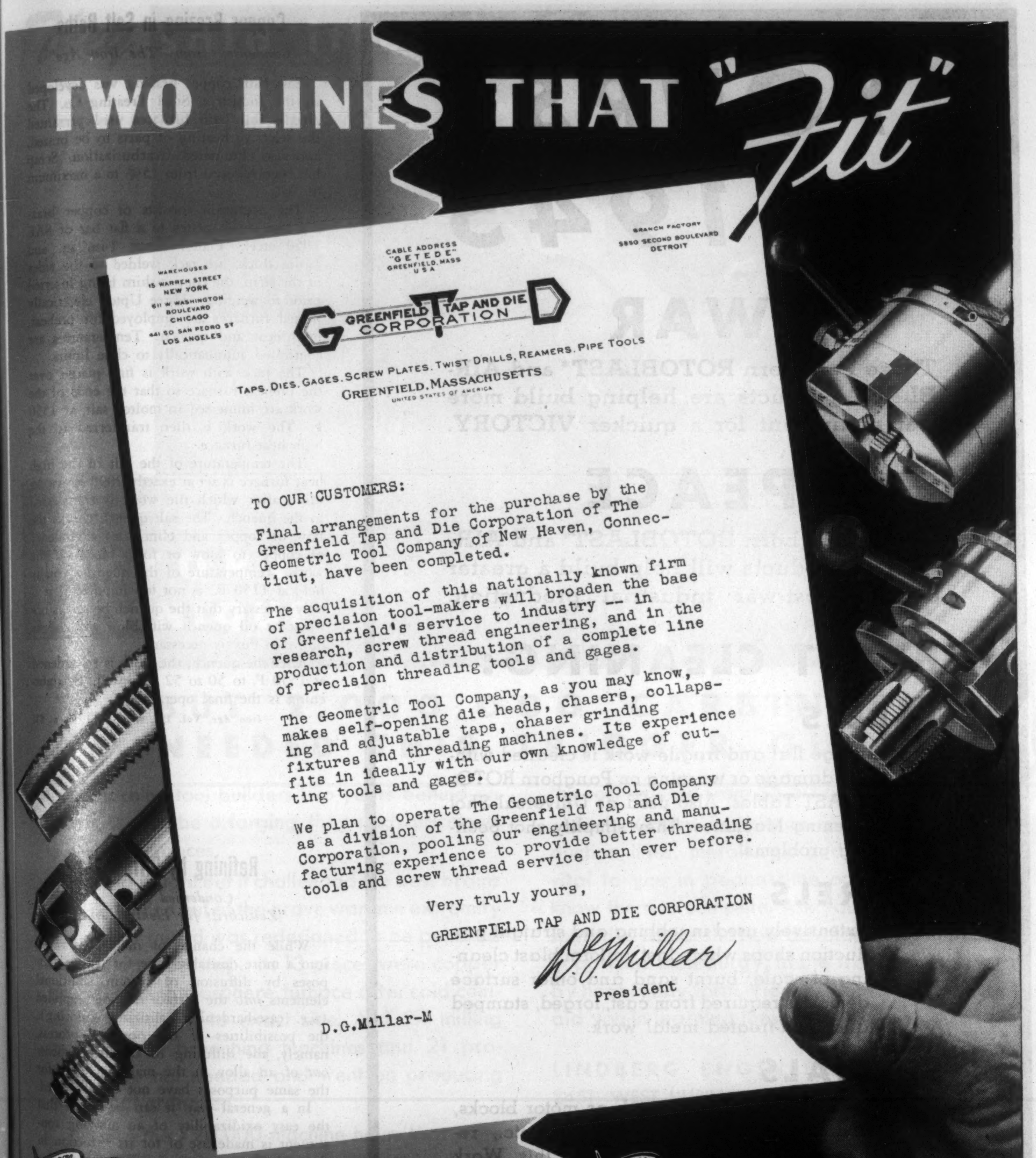
A frequency of 3 to 30 megacycles is used, and the potential must be sufficiently high to provide the required rate of heating within the material. The heating of the material results from the molecular hysteresis caused by the high frequency electrostatic field.

Self-contained units up to 50 kw. output are being offered. Higher power can be obtained by assemblies of these units. The units are being manufactured in sizes to fit certain definite applications.

Fields in which dielectric heating has proved to be economically successful, or in which extensive research has been done, are (1) sterilization of cereal grains and products; (2) manufacture of laminated wood, using moisture-proof adhesives; (3) plastic laminates of diverse character; (4) preheating of plastic preforms for molding; (5) preheating and curing of rubber; (6) curing of resin coated or saturated paper and textiles; (7) dehydration to low moisture content; (8) curing of joints in furniture manufacture; (9) spot fastening or seaming of thin materials; and (10) cooking of certain foods in a very short time.

This method of heating gives promise of wide application in the post-war period because of a number of special advantages it offers: (1) it makes possible results that could not be achieved by any other method. (2) It makes economically possible higher quality products in a number of fields. (3) It increases production in many present machines and methods. (4) Production costs are reduced even while quality is raised. (5) Quality and production can be predicted, timed, and controlled.

—M. J. Maiers. National Electronics Conference Paper, October 1944 meeting.



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TAPS. DIES. GAGES. SCREW PLATES. TWIST DRILLS. REAMERS. PIPE TOOLS
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UNITED STATES OF AMERICA

TO OUR CUSTOMERS:

Final arrangements for the purchase by the Greenfield Tap and Die Corporation of The Geometric Tool Company of New Haven, Connecticut, have been completed.

The acquisition of this nationally known firm of precision tool-makers will broaden the base of Greenfield's service to industry -- in research, screw thread engineering, and in the production and distribution of a complete line of precision threading tools and gages.

The Geometric Tool Company, as you may know, makes self-opening die heads, chasers, collapsing and adjustable taps, chaser grinding fixtures and threading machines. Its experience fits in ideally with our own knowledge of cutting tools and gages.

We plan to operate The Geometric Tool Company as a division of the Greenfield Tap and Die Corporation, pooling our engineering and manufacturing experience to provide better threading tools and screw thread service than ever before.

Very truly yours,

GREENFIELD TAP AND DIE CORPORATION

D G Millar

President

D.G.Millar-M

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GREENFIELD TAP and DIE CORPORATION
Greenfield, Massachusetts

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GEOMETRIC

THE GEOMETRIC TOOL COMPANY
New Haven, Connecticut

YOURS–
IN 1945

WAR

These Pangborn ROTOBLAST* and AIR-BLAST products are helping build more war equipment for a quicker VICTORY.

PEACE

These Pangborn ROTOBLAST* and AIR-BLAST products will help build a greater civilian post-war industrial production.

BLAST CLEANING:

TABLES

Large flat and fragile work is cleaned without damage or warping on Pangborn ROTOBLAST Tables. Also used as Universal Shot Peening Machines. They simplify shot peening problems.

BARRELS

Extensively used in jobbing and straight production shops where fast uniform blast cleaning of scale, burnt sand and other surface defects is required from cast, forged, stamped and heat-treated metal work.

SPECIALS

Line production work such as motor blocks, heads, cylinders, sanitary ware, etc., requires automatic equipment like this. Work is hung upon hooks. Conveyors carry parts through ROTOBLAST Special Cabinets for blast cleaning

*Trade mark of Pangborn Corporation

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WORLD'S LARGEST MANUFACTURERS OF DUST COLLECTING AND BLAST CLEANING EQUIPMENT

PANGBORN CORPORATION • HAGERSTOWN, MD.

Copper Brazing in Salt Baths

Condensed from "The Iron Age"

Salt bath copper brazing was developed by the Industrial Steel Treating Co. The electric salt bath furnaces used permitted the selective heating of parts to be brazed, and also eliminated decarburization. Scrap has been reduced from 15% to a maximum of 3%.

The operation consists of copper brazing two cheek plates to a flat bar of SAE 1050 steel. Plates, about 1-in. sq. and ⅛-in. thick, are tack welded to the sides of the strip, the copper shim being inserted prior to welding. Three Upton electrically heated furnaces are employed for preheat, high heat and quench. Temperatures are controlled automatically to close limits.

The rack with work is first placed over the preheat furnace so that the ends of the work are immersed in molten salt, at 1550 F. The work is then transferred to the high heat furnace.

The temperature of the salt in the high heat furnace is set at exactly 2090 F. for ¾ min., after which the work is transferred to the quench. The salt quench checks the flow of copper and eliminates a tendency of copper to blow or form blobs on the work. Temperature of the quench, usually held at 1150 F., is not too important; it is only necessary that the quench be salt, since water or oil quench will blow the copper out. No flux is necessary.

After the quench, the work is rehardened at 1550 F. to 50 to 52 Rockwell. Straightening is the final operation.

—*Iron Age*, **Vol. 154, Aug. 10, 1944, p. 51.**

Refining by Diffusion

Condensed from "Zeitschrift für Elektrochemie"

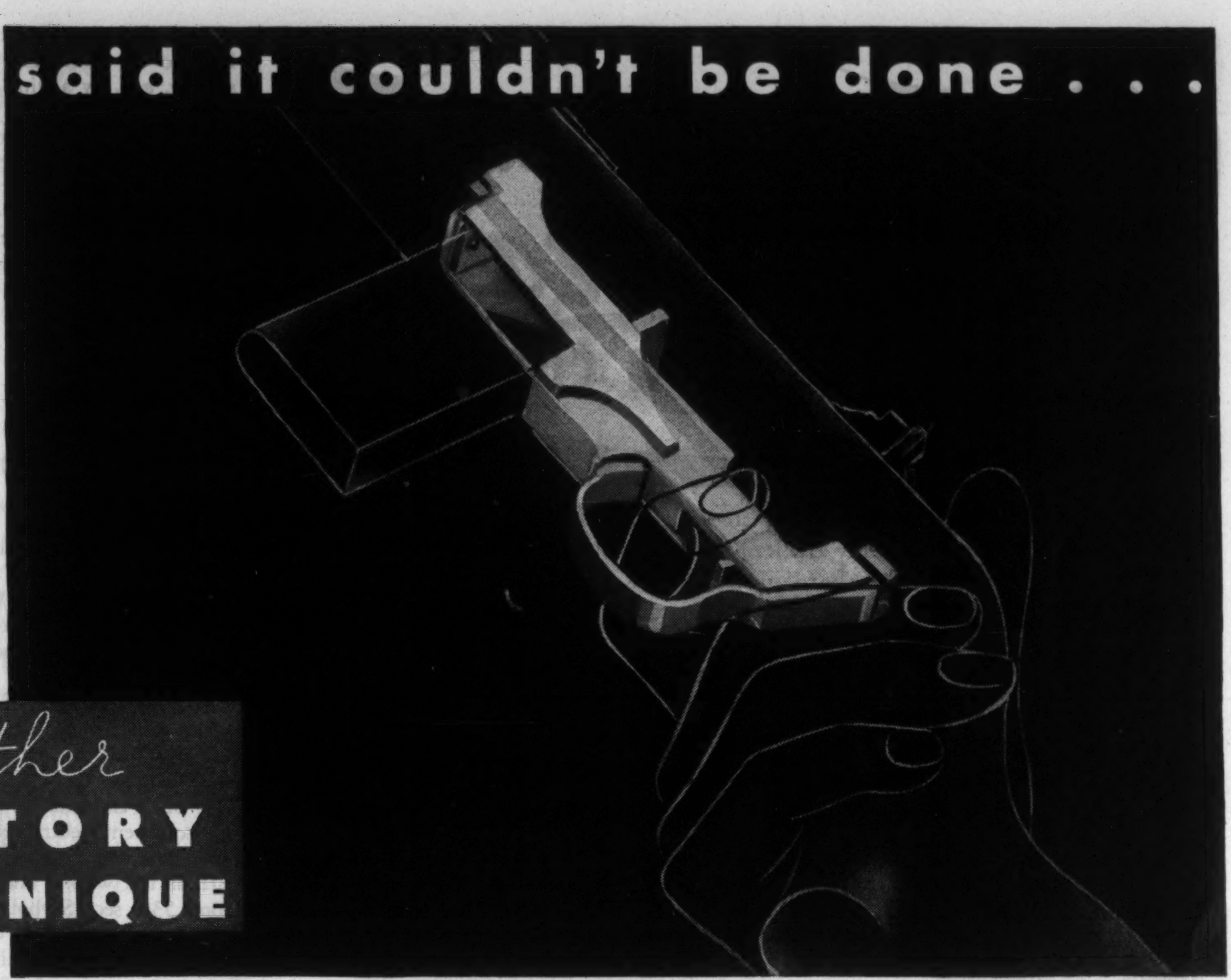
While the change of metallic surfaces into a more desirable state for certain purposes by diffusion of certain additional elements *into* the surface is widely applied (*e.g.* case-hardening, alitizing, coloring), the possibilities of the opposite process, namely, the diffusing of certain elements *out* of an alloy in the marginal zone for the same purposes have not been applied.

In a general way it can be stated that the easy oxidizability of an alloying constituent is made use of for its reduction in the marginal zone, as, for instance, in aluminum-lithium, magnesium-calcium, and aluminum-magnesium alloys. Decarburization of steel in the marginal zone is brought about by annealing in such gases, which form gaseous compounds with the carbon. In the case of dezincization of brass, the high vapor pressure of the zinc seems to play a part.

In principle it is possible to obtain a lowering of an alloying content in the marginal zone also in other alloy systems, but it is important that such physical or chemical properties are found that attack the additional metal in the desired manner and leave the basic metal unchanged.

The compounds generated on the surface

They said it couldn't be done . . .



another **VICTORY TECHNIQUE**

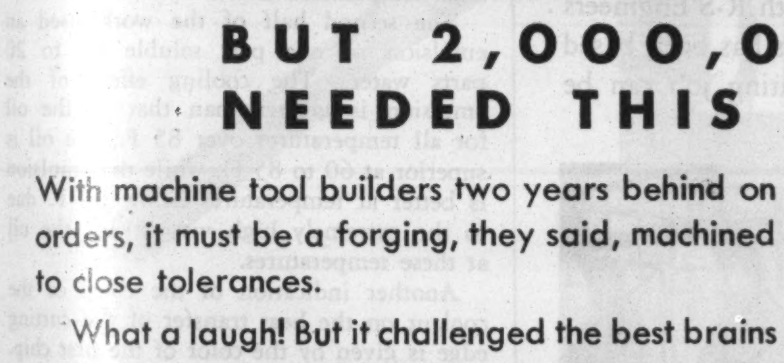
BUT 2,000,000 CARBINES NEEDED THIS TRIGGER GUARD

With machine tool builders two years behind on orders, it must be a forging, they said, machined to close tolerances.

What a laugh! But it challenged the best brains in America and out of the grave wartime extremity this trigger guard was redesigned to be punched from cold rolled strip. Its 13 pieces were copper brazed in an atmosphere furnace after cold coining and shaving to exact size. And 97 milling machines, 16 broaching machines and 21 profilers were not needed and went on producing other vital ordnance.

Besides the 720,000 machine hours that were saved, 635 less tons of steel were required, and *the cost was cut from $6.50 to $1.05 each.*

Such Victory Techniques in manufacture, production lines, metallurgy and assembly can be vital to you in peace-time operation. You must know them to compete. Ask your Lindberg representative about the new developments in brazing, in powder metallurgy, in the treatment of metals by heat in any form. He is eager to do his share to aid you in learning these vital Victory Techniques.



Lindberg Brazing Furnace

LINDBERG ENGINEERING COMPANY
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ARMY E NAVY

Lindberg FURNACES

SUPER-CYCLONE for hardening, normalizing, annealing, tempering
CYCLONE for accurate, low-cost tempering and nitriding
HYDRYZING for scale-free and decarb-free hardening

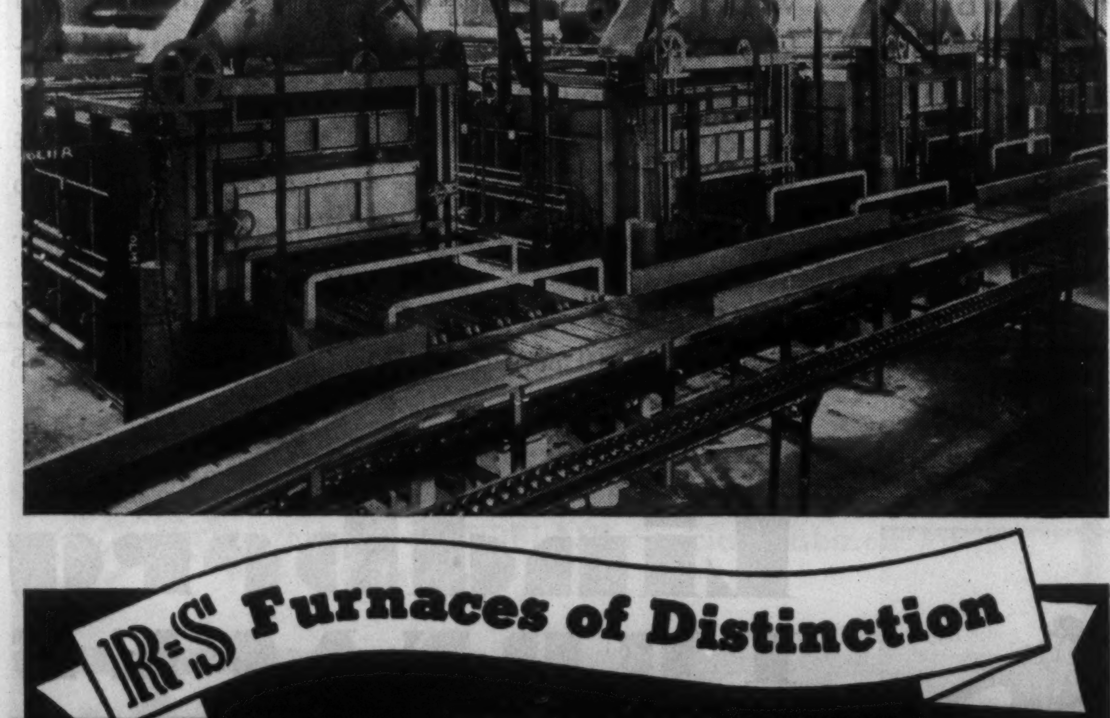
R-S
QUALITY PRODUCTS SINCE 1908

Advanced Engineering
Lowers
PRODUCTION COSTS

Note the battery of R-S Furnaces now producing heavy artillery shells, which are pushed through the four hardening furnaces (illustrated) in parallel conveying tubes. Quenched internally and externally, they leave the quench tanks on continuous conveyors and enter the convection type draw furnaces through which they move on alloy chains. Each of the four harden, quench and draw units is continuous and automatic.

The precise metallurgical results obtained in such war material considerably reduces speculation as to the furnaces of the future. Peace-time production will likewise demand continuous furnaces, automatic handling devices, equal or better metallurgical results and improved production efficiency.

The logical step is to consult with R-S Engineers whose record throughout the years has been based on *how well* a particular heat treating job can be accomplished with economy.



R-S Furnaces of Distinction

FURNACE DIVISION
R-S PRODUCTS CORPORATION

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BUY WAR BONDS

must not form any adhering layers, and have to be continually removed from the surface, *e.g.*, by adding an oxide-dissolving agent to the annealing bath in case oxides are formed. The removal can eventually be enhanced by electrolytic means. The temperature must be so high that the diffusion of the additional element out of the basic metal proceeds with sufficient velocity.

—H. Vosskühler. *Z. Elektrochemie*, Vol. 49, Apr./May 1943, pp. 204-208.

Coolants and Tool Efficiency

Condensed from "American Machinist"

This paper is an abstract of a report on a research program carried out for the Gray-Mills Co. by O. W. Boston, W. W. Gilbert and R. E. McKee, of the University of Michigan. Lathe tool tests were made on SAE 3140 annealed to 207 Brinell with 3/8-in. sq. tool bits of 18-4-1 high-speed steel. A depth of cut of 0.100 in. and a feed of 0.0125 in. per revolution were used in all tests.

A sulfo-chlorinated fatty oil base with mid-continent neutral petroleum and about 0.6 S and 0.5% Cl was used for the first part of the work. The viscosity decreased from 530 sec. Saybolt at 55 F. to 145 Universal at 100 F. to 66 at 150 F. Optimum results were obtained with a coolant fluid temperature of 70 F.

The second half of the work used an emulsion of one part soluble oil to 20 parts water. The cooling effect of the emulsion is greater than that of the oil for all temperatures over 85 F.; the oil is superior at 60 to 85 F., while the emulsion is better at temperatures below 60 F. due to the extremely high viscosity of the oil at these temperatures.

Another indication of the effect of the coolant on the heat transfer of the cutting edge is given by the color of the first chip. The lower temperatures have more cooling effect on the chip and the higher temperatures leave more heat at the tool point.

It is believed that further improvement may be made in commercial cutting by the use of cutting fluids at lower than usual temperatures.

—*Am. Machinist*, Vol. 88, Nov. 9, 1944, pp. 96-99.

Heat Treating Large Pieces

Condensed from "Industrial Gas"

The Southwest Welding & Manufacturing Co. in Alhambra, Calif., specialize in massive construction of alloys and non-ferrous metals that require a variety of stress reliefs, normalizes, and heat treatments.

The stress relief furnace is 16 ft. wide, 16 ft. high, and 50 ft. long. It is externally fired with natural gas from two combustion chambers. If necessary, the fuel can be changed to oil within a few min. The combustion chambers and integrating hot gas duct are made of refractory brick; the

All over the Home Front

ON REPAIR AND MAINTENANCE WORK

P&H HARMOMANG

A Proved Electrode For *high* Resistance to Impact, Abrasion and Wear

Harmomang is an electrode with the work-hardening qualities which suit it especially for the building up or hard surfacing of manganese and carbon steels.

It is a coated moly-manganese electrode with a hardness range up to 43-46 Rockwell "C". It can be used on AC, or for either straight or reverse polarity on DC.

Harmomang is the ideal electrode to use wherever you need protection against both impact and abrasion. For example: for hard surfacing dipper lips, dipper teeth, bucket runners, rock crushers, railway frogs or wherever longer life is desired for parts made of manganese or carbon steels.

Write direct for full information and procedures or see your P&H representative.

A COMPLETE ARC WELDING SERVICE

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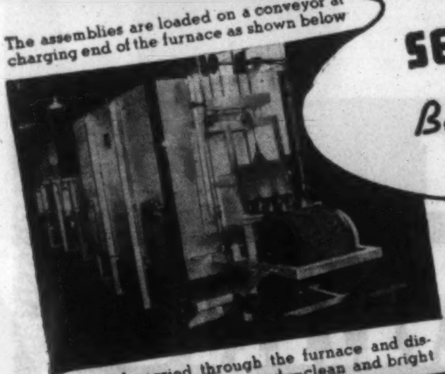
EF FURNACES
For Every Industrial Heat Treating Process

you can join your metal parts
ECONOMICALLY, NEATLY,
SECURELY and CONTINUOUSLY
By the ELECTRIC FURNACE BRAZING METHOD

The assemblies are loaded on a conveyor at charging end of the furnace as shown below



... and carried through the furnace and discharged—securely joined—clean and bright

Aluminum, steel, brass and other assemblies are being securely and economically joined in EF brazing furnaces.

Products which otherwise would be difficult or expensive to make in one piece are being made in several pieces and brazed.

Products requiring several stampings joined or requiring screw machine parts, forgings and stampings to complete the unit, are being neatly, and economically joined, right in the production line.

Strong, leak-proof joints are made and the completed units are discharged from these furnaces—clean and bright. Any number of joints in the same product or any number of pieces can be joined at one time.

Investigate This Process for Joining Your Aluminum, Brass, Copper or Steel Parts.

We will be glad to put samples of your products through one of our furnaces to show you the results you can expect, and give you an estimate on the cost of the equipment to handle your product.

Send for printed matter showing various types of EF brazing furnaces.

The Electric Furnace Co., Salem, Ohio
Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

FURNACES OIL, GAS or ELECTRIC
For Every Heating and Heat Treating Process

Aluminum Brazing
Annealing
Billet Heating
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Process Heating

We Build the Furnace to Fit Your Job
THE ELECTRIC FURNACE CO.
SALEM, OHIO
ELECTRIC EF FURNACES FUEL FIRED

balance is of 3½ in. precast lightweight blocks. A 50,000-lb. charge can be heated from cold to 1200 F. in this car-type furnace in 8 hr.

The 16 ft. by 16 ft. by 25 ft. heat treating furnace can also be fired with either gas or oil. The 10-in. walls are of light weight refractory brick, while the hearth and floor are of refractory brick. The furnace is direct fired and can be heated to 2200 F.

The heat treating and stress relief furnaces are separated by a water cooled middle wall made of a monolithic refractory casting, 9 in. thick in the main center panel and 12 in. thick on the sides. This wall can be removed to join the two furnaces if articles over 50 ft. long are to be stress relieved.

Articles can be moved out of the furnace to the quench within 3 min. The water quench provides 1500 g.p.m. at 135 p.s.i. and can remove 1,000,000 B.t.u. per min. on 320 sq. ft. A jet positioning device makes the quench very flexible. For alloys such as stainless, the quench can decrease the temperature from 2200 F. to under 700 F. in less than 3 min.

—G. E. Stedman. *Industrial Gas*, Vol. 23, Oct. 1944, pp. 19-21, 48.

Sintering of Copper Powders

Condensed from "Metals Technology"

This study was carried out with copper because it represents the simplest form of sintering, in that but one metal is involved and all reactions occur in the solid state. The tests covered three variables, briquetting pressure, sintering temperature, and time in the hot zone. The copper powder used was made from reduced copper oxide and is typical of the grade used for the mass production of parts formed of metal powders.

The apparent density was 2.57 grams per c.c. The flow of the powder is defined as the time in seconds required for 50 grams of powder to flow under the influence of gravity through the Hall flowmeter. The value of the powder used was 27.5 sec.

To prevent seizing and galling of the die during briquetting, 1% by weight of zinc stearate was mixed with the copper. The die used to briquette samples was in the form of a flat tensile bar.

The temperature of the furnace throughout the study was 1750 F., and the briquetting pressure was 60,000 p.s.i., with the time in the furnace hot zone ½ hr. The etchant used was 10% ammonium persulphate.

Merging of adjacent particles during sintering results in further increases in tensile strengths, elongation, density and dimensional changes. Within certain ranges of temperatures and times the structure becomes more uniform as to grain size, the identity of the large and small particles is lost and a general increase in grain size ensues. The structure then resembles that of a cast, wrought and annealed copper. This is caused by a general recrystallization of the briquette.

Roller hearths of INCONEL seamless tubing give long, economical service in SURFACE COMBUSTION furnaces

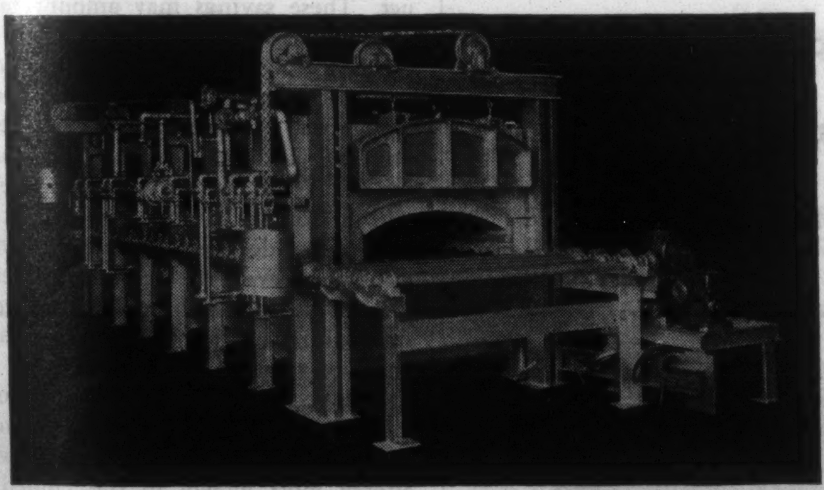
In the Surface Combustion furnace illustrated, the rollers are made of 2¼″ O.D. seamless Inconel tubing with walls .120″ and .134″ thick. The furnace handles 275 8-lb. shovel blanks per hour, heated from cold to 1650° F.

The user of the equipment reports: *"substitutes (for Inconel) have proved unsatisfactory, requiring considerable maintenance with consequent lost production time."*

Inconel seamless tubing, available in a wide range of sizes, is giving excellent service in many high temperature jobs where strength and resistance to oxidation are required . . . it gives long life, cuts down-time, helps maintain steady, trouble-free production.

For further information, write for the new bulletin, "INCO Nickel Alloys for Long Life in Heat Treating Equipment." Address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.



SURFACE COMBUSTION FURNACE, *3′ 9″ wide x 18′ 6″ long, with rollers on 9½″ centers. The rollers are made of strong, heat-and oxidation-resistant Inconel seamless tubing (2¼″ O.D. x .120″ wall x 60″ and 2¼″ O.D. x .134″ wall x 60″). They carry 2200 lbs. of shovel blanks . . . a rated conveyor load of 2.5 lbs. per sq. ft. at 1500°—1650° F.*

NICKEL INCO ALLOYS

MONEL • "K" MONEL • "R" MONEL • "KR" MONEL • "S" MONEL • INCONEL • "Z" NICKEL • NICKEL

Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings . . . Welding Rods (Gas & Electric)

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TREASURE!"
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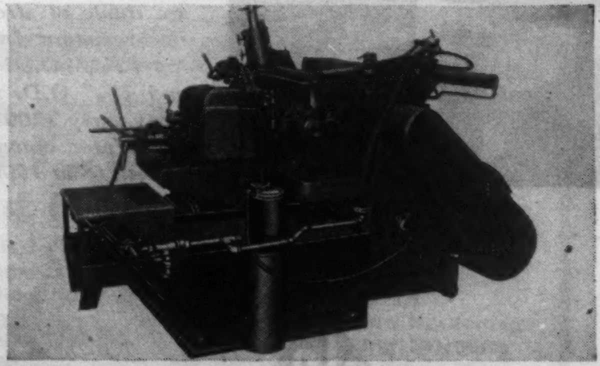
HOFFMAN
COOLANT CONDITIONING

Dig out hidden savings in your plant with Hoffman Coolant Filtration Systems. Hoffman Filters provide an abundant flow of really clean coolant resulting in large savings in maintenance, in coolant replacement, in longer life for machines, cutting tools and grinding wheels, and in fewer rejects.

At right: Hoffman Model I-12VC Filter installed on Cincinnati No. 2 Centerless grinder. Other Hoffman models are available for other machines and for installation in centralized systems.



SEND FOR LITERATURE

U. S. HOFFMAN MACHINERY CORPORATION
223 Lamson St., Syracuse, N. Y.
COOLANT FILTERS • FILTRATION ENGINEERING SERVICE

The shape of the interparticle pore changes from a y-type to an oval type during sintering. There is a steady decrease in interparticle pore size up to the recrystallization range. In that range no distinction can be made between the intraparticle and interparticle pores.

The effect of briquetting pressure is most obvious in regard to porosity—increasing briquetting pressures decreases the porosity. The tensile strength, elongation and density are increased by increasing briquetting pressure, while the shrinkage decreases. The decrease in porosity accounts for the greatest part of the increase in tensile strength.

—C. J. Bier & J. F. O'Keefe. *Metals Technology*, Vol. 11, Oct. 1944, T. P. 1765, 16 pp.

Galvanizing Fluxes

Condensed from "Iron and Steel"

Hydrochloric acid as a flux wash for galvanizing is appealing because of the many and simple conditions under which it can be used with apparent success. It seems inexpensive and, compared with the sal ammoniac used with it, is inexpensive. But in comparison with the newer, non-acid flux washes, the over-all cost of hydrochloric acid is much higher than the price paid for the acid itself would indicate.

Zinc chloride in the place of hydrochloric acid has proven practical but not economical. It functions best in the presence of excessive volumes of water and must be watched closely to avoid flux spotting. The zinc ammonium chlorides proved so much more practical that they are the preferred non-acid type flux washes today.

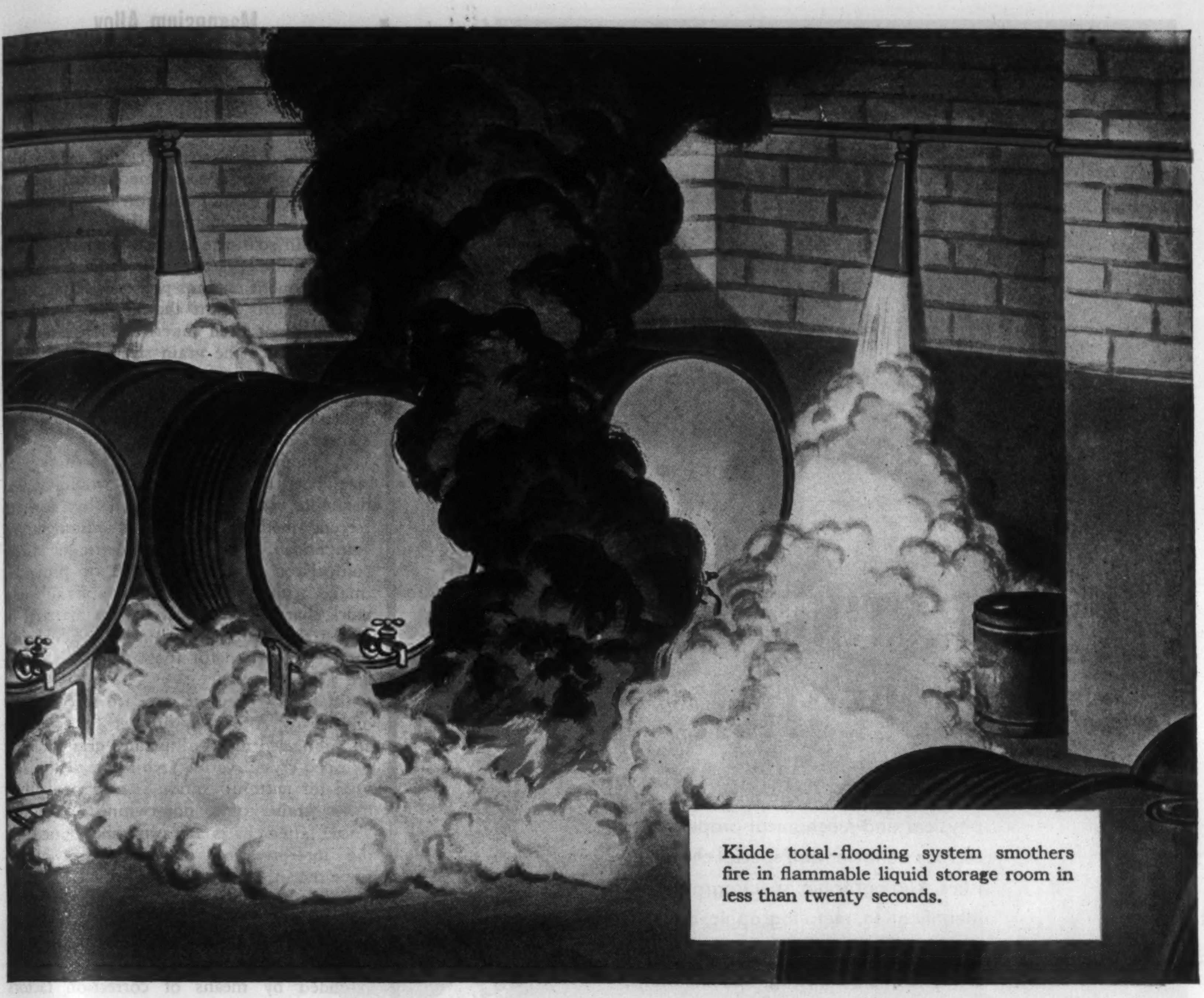
The large benefit in cost from using zinc ammonium chloride flux arises from the possibilities in dross saving, reduced regalvanizing and generally improved product. These savings may amount to almost 75% of the old values. Again, it can be purified and therefore used continuously.

One of the common volatile fluxes is sal ammoniac, or ammonium chloride. It is used to build up a volatile flux fusion on the zinc kettle. It combines with the molten zinc to form various types of zinc ammonium chloride and ammoniated zinc chlorides. However, the fume loss is excessive since it volatilizes at 175 C., whereas zinc ammonium chloride, the other common flux, does not volatilize until 330 C.

This second type of flux is in two forms, the first containing 44% ammonium chloride, the second 54%, the one which is offered most widely in the United States. The advantage of zinc ammonium chloride is that it keeps the ammonium chloride at useful work. There results less fuming, longer flux life, lower flux consumption, though somewhat more sluggish fusions.

This 54% type is popularly known as No. 20. It is self-foaming, wets the pickled and rinsed surfaces thoroughly, and maintains uniformly frothy fusion for long periods. It contributes to the lowest cost, highest quality galvanizing.

—A. T. Baldwin. *Iron & Steel*, Vol. 17, Oct. 1944, pp. 645-646.



Kidde total-flooding system smothers fire in flammable liquid storage room in less than twenty seconds.

BEFORE TOUGH FIRES GET TOO TOUGH

. . . *blast them out with Kidde!*

In fighting the tough fires—the fast-moving ones that break out in flammable liquids (class B); and the hard-to-get-at types that start in electrical installations (class C)—you've got to smother them fast or they'll spread beyond control in a few minutes.

Ordinary water-type extinguishers can't control these tough fires. But built-in Kidde systems, employing carbon dioxide, will smother them in a matter of seconds. That is why Underwriters' and Factory Mutual Laboratories approve Kidde for fighting *both* these types of fire.

Some of the Kidde built-in systems are so designed that the fire can be automatically isolated, and the room quickly filled with flame-suffocating carbon dioxide. This gas—being dry, inert, odorless and non-toxic—leaves no after-fire mess to be cleaned up, cannot damage any materials; and does not contaminate or otherwise spoil costly processes. In brief, Kidde is one of the speediest, cleanest and most effective fire extinguishers in use today.

So, check this list (at right) now. Does even *one* of these hazards exist in your plant? If it does, write Kidde today. Ask to have a Kidde representative call upon you. He'll be glad to share his fire-prevention know-how with you.

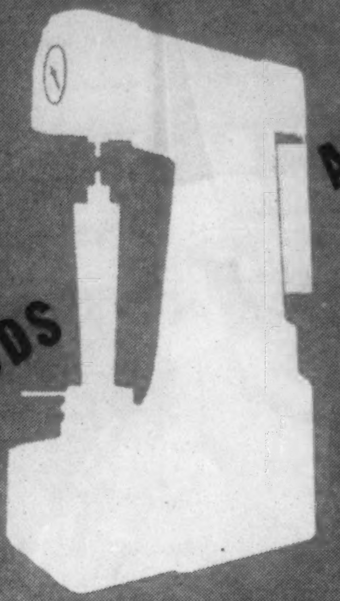
K
Kidde

KIDDE KILLS TOUGH FIRES

Process Rooms
Ovens
Spreaders
Motors
Storage Rooms
Mixers
Coaters
Transformers
Dip Tanks
Agitators
Washers
Quench Tanks

Walter Kidde & Company, Inc. • 140 Cedar Street • New York 6, N. Y.

METHODS AND PROCESSES



TESTING and INSPECTION

Testing methods and equipment for physical and mechanical properties, surface behavior and special characteristics. Radiographic, spectrographic, identification, metallographic, dimensional and surface inspection. Stress analysis and balancing. Specifications, standards and quality control.

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Magnesium Alloy Grain-Size Determination

Condensed from "ASTM Bulletin"

It is a matter of general understanding that finer grain structures in magnesium alloys possess superior mechanical properties, greater ease of solution heat treatment, and improved machinability. When this fine grain structure is once fixed by present superheating practices, it tends to persist in subsequent castings produced from superheated ingots, even though the secondary melt has not been superheated to the same degree. Since the grain size of magnesium has such an important bearing upon the mechanical properties of the alloys, it is necessary to establish a recognized and standard method for recording it.

A standard method of reporting grain size, both here and abroad, would appear desirable, whether measured by the intercept method or by the micrographic comparison method. Planimetric or direct comparison of a micrograph or projected image with standard micrographs or network charts is recommended for material in which the grains are equiaxed, and Heyn's intercept method for those in which grains are not equiaxed.

Of the two sets of standard micrographs offered by A.S.T.M., the set for wrought and annealed alloys illustrates grains of the twinned crystal variety, while the set usually used for austenitic grain size in steel illustrates grains of a non-twinned character. These latter charts are admirably suited for the interpretation of magnesium alloys, since they are typical of the structure found.

While the austenitic charts are prepared for comparison at 100 magnifications, and is designated numerically from 1 to 8 in A.S.T.M. Index Numbers, the range can be extended by means of correction factors and use of various magnifications other than 100 diameters.

Under the proposed system, correction factors would permit interpretation of grain size over a wide range by utilizing changes in magnification. Correction factors necessary for application at various magnifications are as follows:

Magnification	6.25	12.5	25	50	100	200	400	800
Correction	−8	−6	−4	−2	0	+2	+4	+6

To illustrate the use of these factors, if a grain size of 12 is found to match a specimen micrograph taken at 50 diameters, the grain size under the proposed system would be 12-2, or 10. If the specimen micrograph is taken at 400 diameters and matches the standard micrograph with grain size 10, the grain size under the proposed system would be 10+4, or 14.

The most probable range of grain sizes for commercial application would be between 7 and 16. These sizes were obtained by labeling the present austenitic network chart 9 sizes greater than is the austenitic practice, so that the present No. 1 becomes No. 10 of the new standards.

It will be found desirable with the majority of cast magnesium alloys to give the specimen a solution heat treatment. This can be beneficially followed by a 15-

Aircraft bolts being tested on a Riehle P2 Precision Universal Hydraulic testing machine. Below --One of National Lock Company's nickel steel aircraft bolts.

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Sonntag Scientific Corporation, an organization of well-known testing engineers, have for many years devoted themselves exclusively to fatigue and vibration research and the development of new machinery for this purpose.

Development of a number of new Universal Fatigue Testers has been successfully completed and the machines are exclusively sold by the Baldwin Southwark Division of The Baldwin Locomotive Works.

The testing laboratory which has just been completed in Greenwich, Conn., includes the most up-to-date dynamic testing equipment, such as large-size rotating beam fatigue testers, universal fatigue testers of the constant alternating load type for tests in tension, compression, bending and torsion of specimens or structures. Supplementary equipment for static tests is also available.

SONNTAG SCIENTIFIC CORPORATION

15 Seneca Place Greenwich, Conn.

to 30-min. aging treatment at approximately 200 C. This permits a definite outline of the grain structure and allows much more positive results than with specimens not heat treated.

—C. H. Mahoney & A. L. Tarr. *ASTM Bulletin*, No. 130, Oct. 1944, pp. 15-19.

Efficient Gear Measuring

Condensed from "Maschinenbau der Betrieb"

The main requirements in gears are: (1) They should run noiselessly and without vibration; (2) efficiency should be high; (3) tensile, bending, fatigue and impact strength of teeth should be high; (4) wear and tear of flanks should be small; and (5) transmission of movement should be very accurate. The high degree of accuracy in measuring gears to ensure their meeting these requirements necessitates complicated and expensive instruments.

Measurement can take place during or immediately after production (form of tooth, pitch, true running, thickness of tooth and width of space, angle of obliquity or direction of tooth) or on the finished gear (measurement of finished gear and determination of any defects with regard to the function of the gear).

A reliable instrument for testing the form of the flank is indispensable; one such machine tests the face line of the teeth by continuous adjustment of the base circle radius. A test curve should be taken of the first wheel of each new batch. There is still no workshop instrument for testing the tooth flanks, but one will probably be developed using either a feeler or optical devices.

Chordal or Circular Pitch

There is some question as to whether the chordal pitch or the circular pitch should be tested; the former is generally sufficient for ground gears, while the latter must be used for milled gears. The answer is doubtful with slotted or scraped wheels.

The measurement of the chordal pitch gives a complete explanation of the real state of a gear only if the defects are determined in their absolute magnitude. For this test, a hand measuring instrument is largely used; the usual clock dial micrometer must be replaced by a precision feeler.

Circular pitch can be tested with a fixed stop and mobile precision feeler; however, any deviation from true running is generally included in the measurement. A correct determination of the summary of deviation from the circular pitch is only possible by means of the measurement of angles, preferably with theodolite and collimator. This method is long and should be used solely for testing the pitches of gear cutting machines.

True running of the teeth is largely influenced by the bore of the wheel, the spindle through the bore, and the spindle bearings. The use of a cylindrical spindle as part of the support of the wheel being tested should be avoided. The simplest and most reliable support is a mandrel of conical form. The usual clock dial micrometers are not sensitive enough, but precision feelers should be used.

These forgings look alike but . . .
they are of different steels.

the **DuMONT** *Cyclograph*

SORTED THEM INTO TWO LOTS

➧ Yes, accidents will happen, even in the best regulated plants. Especially metallurgical mixups.

These forgings are of mixed steels—NE 8442 and NE 8744. Visually, they cannot be told apart. Usual inspection methods involve destruction of the pieces. What to do?

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1750 of these forgings were precisely checked and manually sorted in 3 hours, into the two lots of steel, and thereby salvaged for use in a busy war plant.

Grading and sorting according to analysis, structure, case depth, decarburization, plating thickness, internal stresses—on ferrous and non-ferrous metals—such is the service rendered by the Cyclograph.

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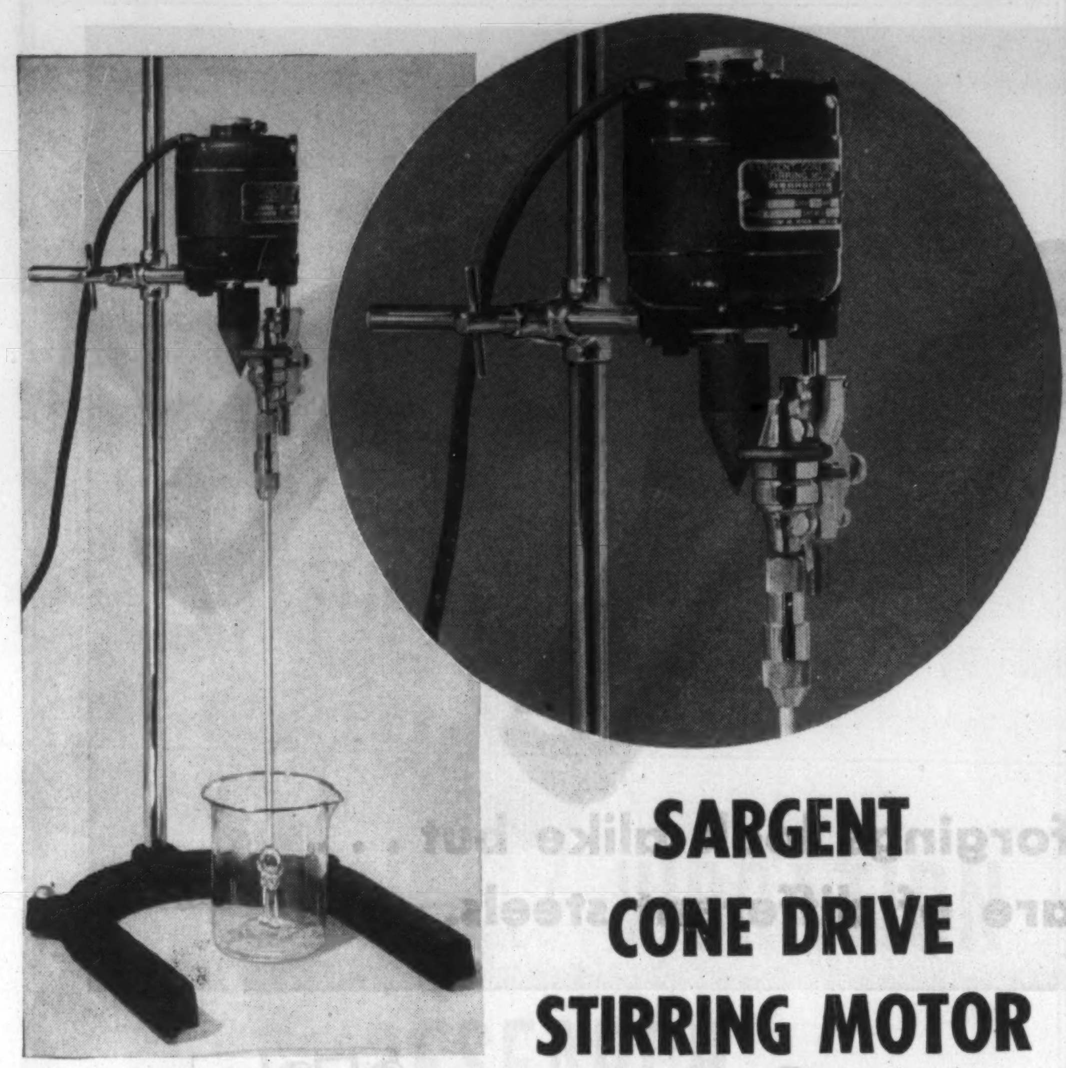

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S-79225 Support only for Sargent Cone Drive Stirring Motor (illustrated above). Designed with considerable mass to minimize support vibration. The heavy U shaped base accommodates vessels up to six inches in diameter and larger vessels can be placed on top of the base which has a flat surface. Supplied with a ⅝" rod, 30 inches long and adjusting screws to insure a solid four point support on any surface. Each....................**$10.00**

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Michigan Division: 1959 East Jefferson, Detroit 7, Michigan

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If specially small allowances are unnecessary, a truing test is required only for spaces at more or less large distances. It can usually be replaced by rolling the test piece on a master wheel in a two flank instrument using perhaps a run of ball or roller shaped teeth or a worm.

Truing and Backlash

Backlash is largely influenced by truing defects, by the allowance in the center distance, and particularly by the variation of the thickness in the teeth. The latter may be measured in the workshop with special calipers or instruments equipped with sensitive precision feelers.

In spur gears the testing for parallelism of the flanks to the center line is still rare. Reliable and numerical results can be obtained only by contacting each tooth flank separately by a feeler, which is best fixed, while the gear, placed on centers, is moved longitudinally.

In contrast to the above testing with regard to individual defects, which takes a considerable amount of time, the test by rolling the workpiece against a master will be used more and more in the future as an acceptance test. The generally approved double flank testing method shows many fundamental defects.

Although rarely used, the single flank method is preferable. It combines the wheel to be tested with a mate on the same centers on which it has to work afterwards so as to determine the difference in angular velocities originating from defective gearing.

It is possible to consider testing the total defect only if a sufficient number of rolling-off gages are at hand. Recent developments have enabled production of master wheels with sufficient accuracy, except for master wheels with small modules below 1 mm.

—K. Bürger. *Maschinenbau der Betrieb*, Vol. 22, Mar. 1943, pp. 101-107; as abstracted in *Engineers' Digest* (American), Vol. 1, Oct. 1944, pp. 637-641.

Determination of Surface Quality

Condensed from "Light Metals"

Requisites of an adequate technique for examining and measuring surface quality are: Allow examination of rough as well as polished surfaces; applicable to flat, cylindrical and spherical faces; different stages in machining easily recognized; easy to handle and suitable for any workshop; standardized so that different instruments give corresponding results; result must correspond to the roughness measured by an absolute method.

If light be directed onto a well polished metal surface and examined with a metallurgical microscope with light-ground illumination, most of the light is seen to be reflected into the microscope, apart from the reflection losses at the lenses and at the surface of the test piece. With scratches and irregularities, a proportion of the incident light is reflected or deflected and will only partly enter an objective with small aperture. The rougher the surface, the smaller will be the amount of light entering the microscope.

With dark-ground illumination the light is directed upon the metal surface at such

Q. What X-ray film for Gamma exposures when time is relatively unimportant?

A. Kodak's Type "A"

KODAK'S Type "A" Industrial X-ray Film, with lead foil screens, is the choice where the materials to be examined can be exposed overnight or when thin-walled castings or welded assemblies are being inspected. Type "A" has fine grain and high contrast and as a result gives superior definition where long exposures are permissible. This increased radiographic sensitivity heightens the visibility of small defects and frequently more than compensates for the longer exposure time required.

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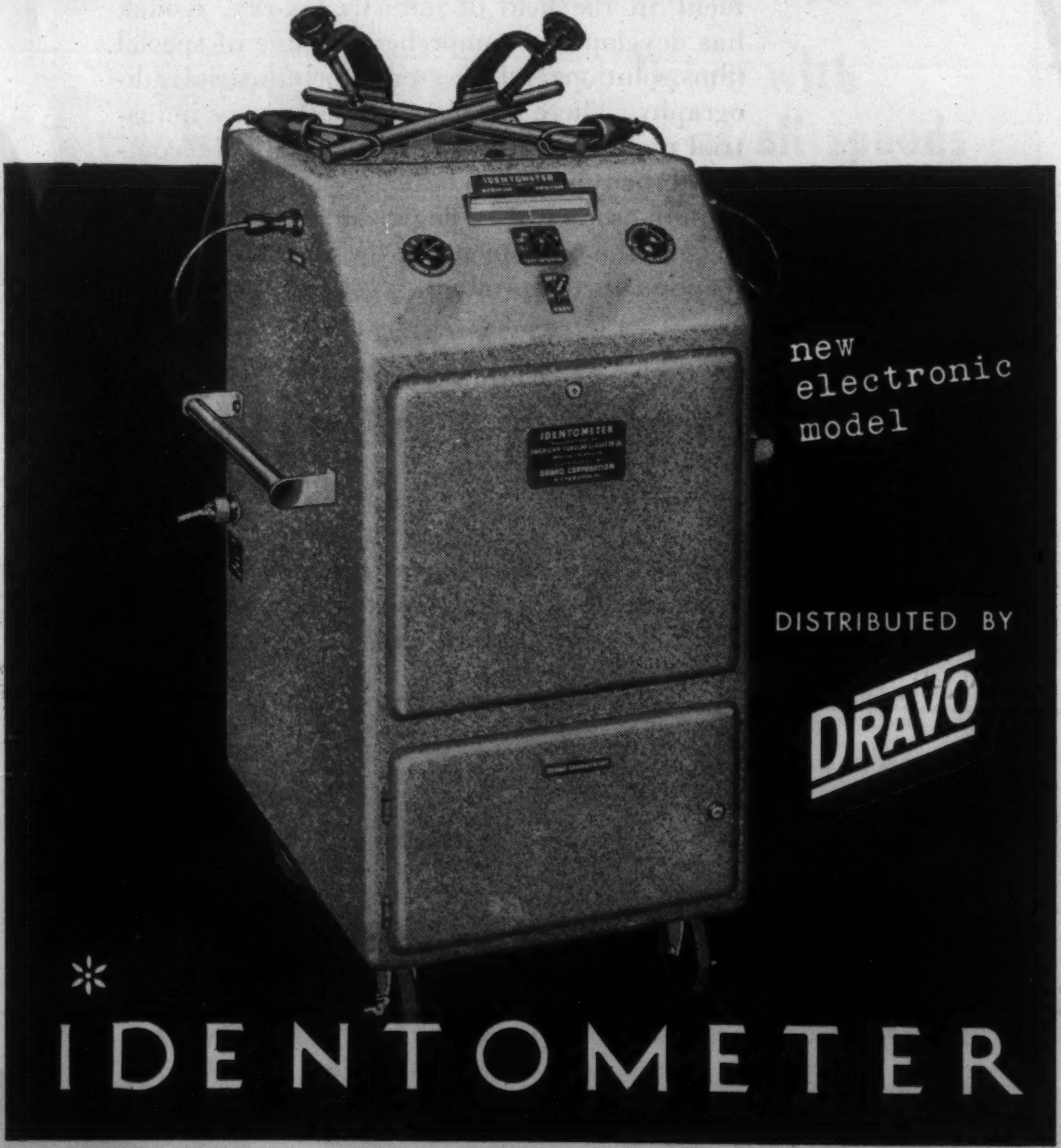
An operator, with only a few hours training, can use Identometer to test most rolled or forged ferrous material and provide a safeguard against error. Read the whole story of this new metallurgical tool!—What it is and how it works is told in Bulletin 1A. Address—Dravo Corporation, National Department, 300 Penn Avenue, Pittsburgh 22, Pa.



AN ELECTRICAL INSTRUMENT FOR THE INSTANT AND ACCURATE IDENTIFICATION OF MOST ROLLED OR FORGED FERROUS ALLOYS BY THE USE OF REFERENCE SPECIMENS

an angle that no directly reflected light can enter the objective. A smooth surface reflects only a small amount of light with dark-ground illumination, while a rough surface reflects or diffuses more light. A thorough surface examination involves both kinds of light.

Previous to the photometric method, the light-slit and stylus methods prevailed. Photometric measurement is based on the ratio of the photo-electric current with light-ground to that with dark-ground illumination. The light-slit and photometric methods are equally suitable for measuring rough faces. However, the photometer is superior in the long run because it can measure polished test pieces that are beyond the capacity of the light-slit method. Photometric measuring is also better than the stylus method.

On turned and ground surfaces the exactness of measurement for photometric methods is the same as for the other two methods. The photometric system, however, is more rapid because the other two methods require photographs to be made, especially if high accuracy be essential.

—*Light Metals*, Vol. 7, Oct. 1944, pp. 497-500, 501-505.

Demagnetization During Magnetic Inspection

Condensed from
"Aeronautical Engineering Review"

Demagnetization between the circular and longitudinal magnetizing operations of Magnaflux inspection has hitherto been thought necessary, requiring the use of extra man-hours and equipment. Yet investigation has shown that it is both unnecessary and undesirable.

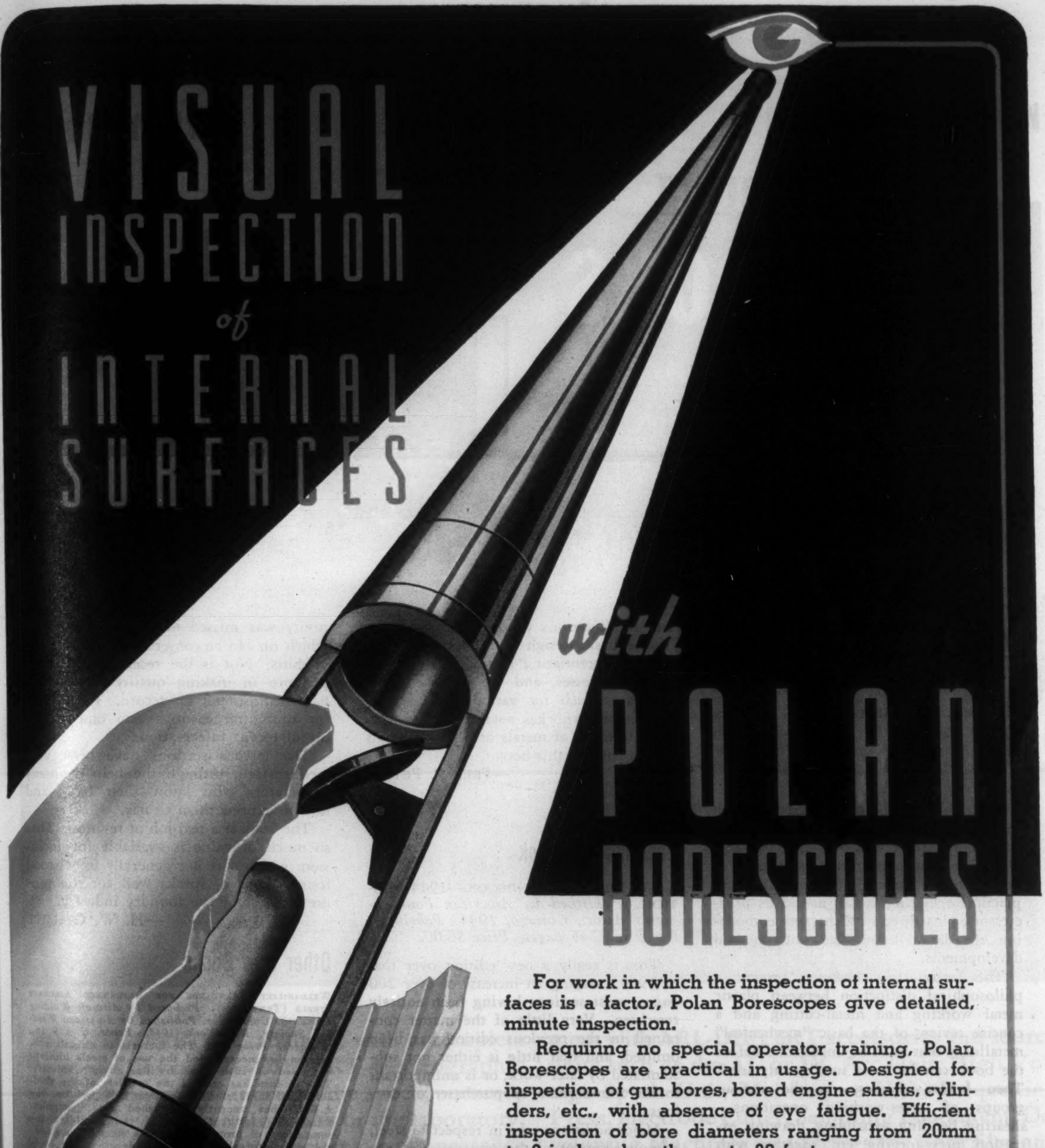
In the continuous method of inspection, the indicator is applied while the parts are being magnetized; the residual method, if applied after magnetization. Passing current through the test part along its axis is called circular magnetization; coil or longitudinal magnetization brings out defects transverse to the axis.

The standard procedure has been: Magnetize in one direction; inspect; demagnetize; magnetize in other direction; inspect; demagnetize; rinse. To eliminate the first demagnetization, one must be certain that the effectiveness of the second magnetization in finding flaws will not be decreased by the premagnetized condition of the part.

By applying the same magnetizing force in the opposite direction, the part is completely reversed in magnetism and is fully as strong, or very nearly equal, in magnetic strength to the original field. Thus, when we change the configuration of the molecular magnets from circular to longitudinal, the longitudinal field will produce its full effect just as if the part were unmagnetized to start with. In fact, the second operation is often more successful without the demagnetization, and in many tests it is never inferior to the older method of demagnetization.

Tests were made on aircraft piston pins, shear blades and hollow cylindrical bearings.

—M. L. Mages. *Aeronautical Engineering Rev.*, Vol. 3, Oct. 1944, pp. 31, 33, 35, 45.



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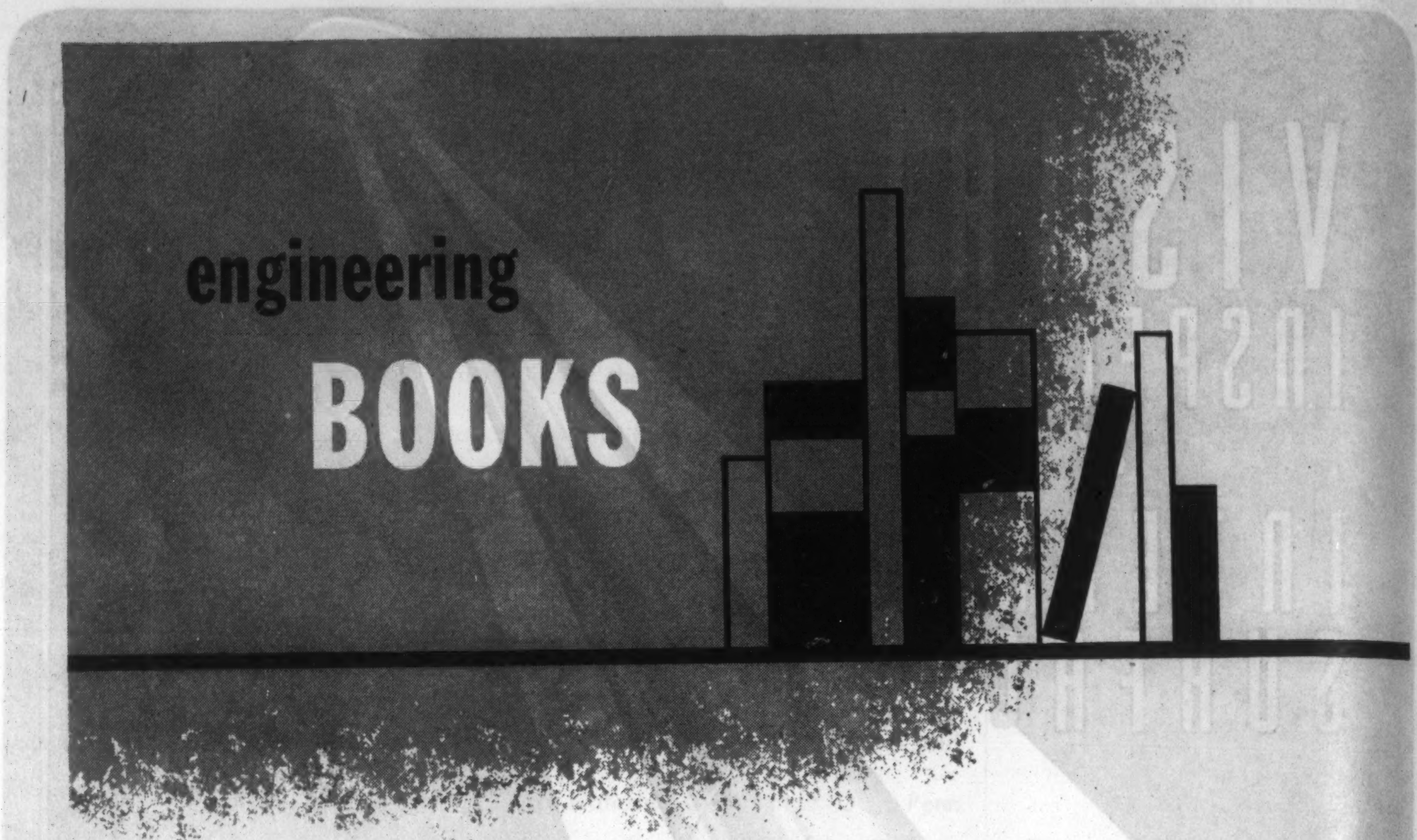

engineering BOOKS

Press Working of Metals and Non-Metals

PLASTIC WORKING OF METALS AND NON-METALLIC MATERIALS IN PRESSES, THIRD EDITION. *By E. V. Crane. Published by John Wiley & Sons, Inc., New York, 1944. Cloth, 5½ x 8½ in., 540 pages. Price $5.00.*

Little but praise can be offered by even the most captious reviewer of this third edition of Crane's book on plastic working. It contains the same meaty assortment of flow theory, press and die engineering and practical operating factors as did its predecessors, plus three new chapters embodying the latest knowledge and method developments.

The introductory chapters present a philosophical distinction between plastic metal working and metal-cutting and a concise review of the basic "mechanical" metallurgy that must be understood before the book can be most intelligently used. Then follow chapters on the various groups of press-working operations—shearing, bending, expanding, drawing, extrusion, press-forging, etc., together with recent developments in small lot and diversified production (*e.g.* using soft or flexible dies or punches), and in plastics molding, powder metallurgy, ceramics, plywood laminates, etc.

One of the best features of this book is Appendix I, which contains many charts for quick computation of pressures, work, speeds, capacities, etc. for various types of equipment and different jobs.

The author, who was associated with a large manufacturer of both mechanical and hydraulic presses (E. W. Bliss Co.), has given much more emphasis in the text and illustrations to the mechanical type of machine. An interesting and useful addition to the chapter on Press Characteristics and Modifications would be a discussion of the basic design and operating principles differentiating hydraulic from mechanical presses, and the relative suitabilities of each for various jobs.

Everyone who has anything to do with press forming of metals or plastics should have a copy of this book.

—FRED P. PETERS

Castings Handbook

CAST METALS HANDBOOK—1944 EDITION. *Published by American Foundrymen's Assoc., Chicago, 1944. Fabrikoid, 6 x 9 in., 745 pages. Price $6.00.*

This is really a new edition over that of 1940, carrying an increase of over 200 pages, most sections having been entirely rewritten. Very little of the matter contained in the previous edition has been omitted, and that little is either not substantiated by later work, or is unimportant to the foundryman or purchaser of castings.

Major additions are: in respect to steel, acknowledgment of the resurgence of the converter, discussions of mass effect, fatigue-resistant designs, use of blind risers, and of tapered sections. Hot tears and non-destructive testing are given considerable space.

In respect to cast iron: fatigue and wear are more fully discussed, as are stress relief, annealing, and heat treatment. Charts, showing graphite flake size and type, are inserted in the back of the book.

As to white iron: comment is made on the effects of Te and B.

In the non-ferrous section, plaster molds and centrifugal casting receive mention. The non-ferrous section, on the whole, has not been so well brought up to-date as the other sections, for the opportunity was missed to stress the ways in which tin can be conserved in bronzes and babbitts. Nor is the recently gained experience in making quality magnesium-base castings put on record. The section on aluminum castings also omits some useful recent information.

The ferrous sections have been very well revised, through the help of many cooperators who know their facts, and how to express them clearly.

The book is a real job of revision. That so much of value is available for inclusion, which was not generally understood four years ago, speaks well for the progressiveness of the foundry industry.

—H. W. GILLETT

Other New Books

WELDABILITY STANDARDS FOR ALTERNATE AIRCRAFT STEELS (TENTATIVE). *Prepared by Aircraft Welding Standards Committee. Published by American Welding Society, New York, 1944. Paper, 6 x 9 in., 14 pages. Price 25c.* The increase in aircraft production has necessitated the use of steels hitherto not used or little used by the aircraft industry. This in turn has created the problem of the weldability of these steels. To meet this problem, the A.W.S. has recently published this pamphlet, which sets forth a series of tests enabling the comparison of proposed alternate steels with standard aircraft steels. The standards are based on a research investigation of the problem covering both arc and gas welding. Included are the Tee-Bend Test; Transverse Butt-Joint Tension Test Tubing; Welded Double-Tube Triangle Test; and so forth.

CORRECTION

A review of "Manganese in California—Bulletin No. 125," which appeared in our November issue, stated that this booklet was "Free to those interested." This was erroneous, as a price of $3.00 is charged.

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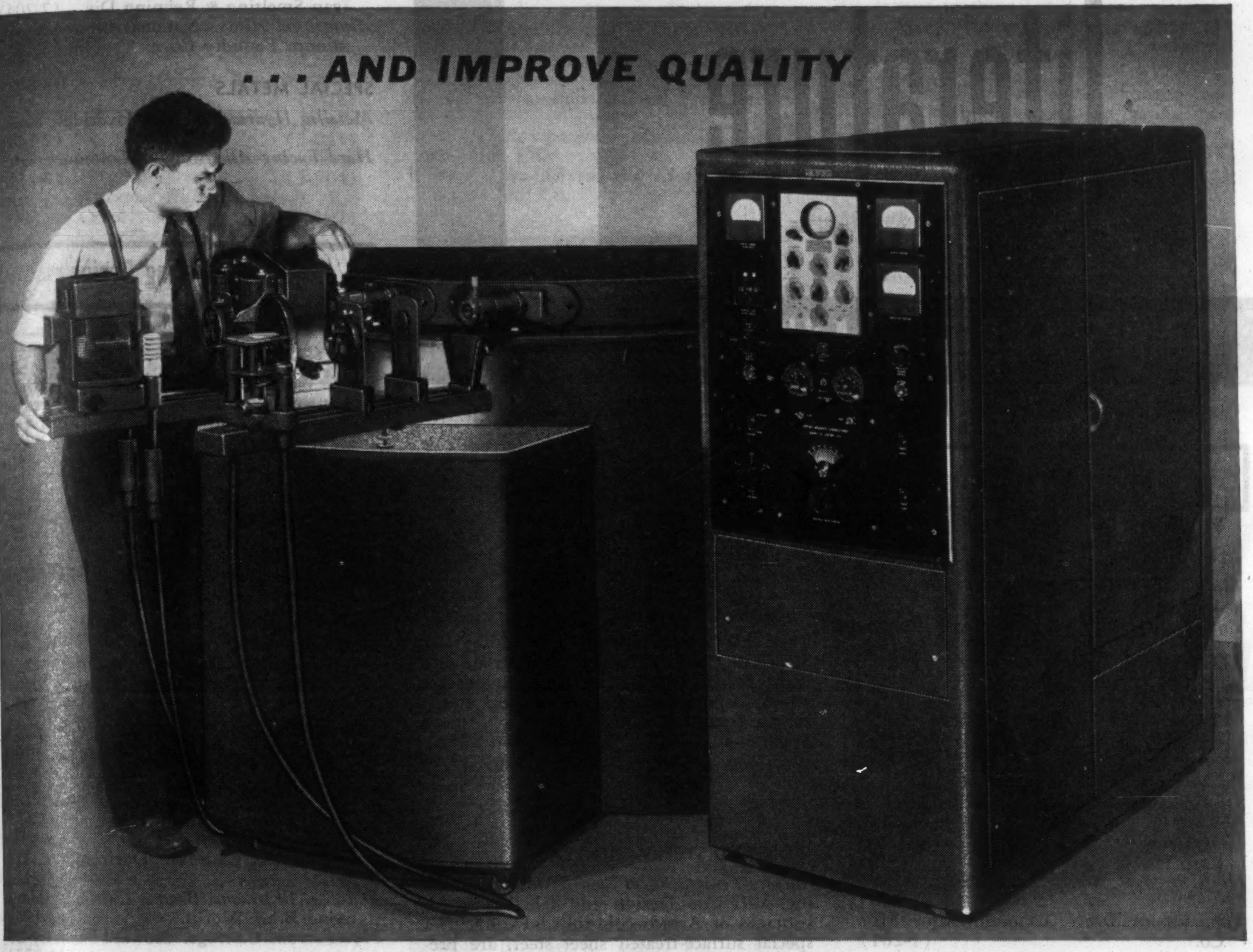

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Electric Furnace Specialty Steels. Jessop Steel Co. An interesting, 16-page catalog presents a number of illustrated articles on electric furnace specialty steels for the metal working field. (1-283)

Steel Analysis Chart. American Steel & Wire Co. (1-218)

High-Strength Steel. Great Lakes Steel Corp. (1-2)

High Strength Steel. Inland Steel Co. (1-90)

Titanium in Steel. Titanium Alloy Mfg. Co. (1-201)

CARBON STEELS

Cold-Finished Bar Steels. Bliss & Laughlin, Inc. Complete data on cold-finished bar steels, for all types of mechanical equipment, processing machinery, etc. are presented in a 32-page, well-illustrated bulletin. (1-287)

Steel Bar Planning Guide. La Salle Steel Co. (1-281)

Spring Steel. A. R. Purdy Co., Inc. (1-189)

HIGH SPEED STEELS

Tungsten-Molybdenum High Speed Steel. Latrobe Electric Steel Co. (1-175)

STAINLESS STEELS

Stainless Clad Steel ("Pluramelt"). Allegheny Ludlum Steel Corp. (1-161)

Heat Treatment of Stainless Steels. Rustless Iron & Steel Corp. (1-279)

TOOL AND DIE STEELS

Cutting Tools. Crucible Steel Co. This attractive, 26-page catalog profusely illustrates and describes a variety of cutting tools, made of Rexalloy, a non-ferrous cutting alloy, for use in "Middle-Range" machining applications. Specifications and list prices are included. (1-285)

High-Speed Tool Steel. General Aircraft Equipment, Inc., Tool Div. Tools made of Borcoloy cutting steel, a high-speed tool steel containing boron and cobalt, are discussed in a 4-page folder. (1-288)

Tool and Special Steels. Simonds Saw & Steel Co. Complete data on high-grade tool and special steels, including high-nickel alloys, magnet steels and alloys, shock steels, etc., are presented in a compact, 74-page catalog. (1-284)

Heat Treating Guide. Carpenter Steel Co. (1-280)

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Surface-Treated Sheet Steel. American Rolling Mill Co. Design and fabricating advantages of Armco cold-rolled Paintgrip, a special surface-treated sheet steel, are presented in a 12-page illustrated bulletin. (1-286)

Steel Stock List. Joseph T. Ryerson & Son, Inc. (1-169)

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Aluminum Bronze. American Manganese Bronze Co. (2-173)

Engineering Bronzes. Bridgeport Brass Co. (2-275)

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Phosphor Bronze. Phosphor Bronze Smelting Co. (2-213)

Copper Alloys for Mechanical Uses. Revere Copper & Brass, Inc. (2-126)

Phosphor Bronze, Etc. Riverside Metal Co. (2-223)

Special Copper Alloys. Seymour Manufacturing Co. (2-101)

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Aluminum—the Versatile Metal. Reynolds Metals Co. An attractive, 8-page bulletin describes and illustrates the versatility of Reynolds aluminum and aluminum alloys, and includes a complete data sheet of their properties and applications. (2-279)

Aluminum Alloy Specifications. American Smelting & Refining Co., Federated Metals Div. (2-253)

Ingot Metal. Bohn Aluminum Co., Michigan Smelting & Refining Div. (2-204)

Aluminum Alloy. National Bronze & Aluminum Foundry Co. (2-187)

SPECIAL METALS

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Hard Facing Alloys. Wall-Colmonoy Corp. (2-251)

3. Engineering Design

ALLOY CASTINGS

Heat and Corrosion-Resisting Castings. Sterling Alloys, Inc. Engineering data on Stermet heat- and corrosion-resisting castings, and their typical applications, are presented in a 12-page, illustrated bulletin, No. 200. (3-513)

Nickel-Chromium Castings. Electro Alloys Co. (3-326)

CASTINGS—IRON, STEEL, NON-FERROUS, ETC.

Heat-Resisting Castings. Meehanite Research Institute. Bulletin No. 21, four pages, discusses six heat-resisting types of Meehanite castings, and illustrates various applications. (3-518)

Alloy Castings. Michiana Products Corp. Complete data on heat- and corrosion-resistant alloy castings are presented in a 16-page illustrated bulletin, No. 110. (3-512)

Special Castings. Advance Foundry Co. (3-381)

Acid-Resistant Castings. Duriron Co., Inc. (3-214)

Data on Brass and Bronze Castings. Hammond Brass Works. (3-194)

Non-Ferrous Castings. Howard Foundry Co. (3-333)

Cast Steel Breech Rings. Ohio Steel Foundry Co. (3-81)

Precision Casting. J. R. Wood Products Corp. (3-501)

DIE CASTINGS, PRECISION CASTINGS, ETC.

Precision Castings of Ferrous Alloys. Bergen Precision Castings, Inc. This 4-page folder discusses the advantages of using ferrous precision castings for parts of close tolerances. (3-511)

FORGINGS

Drop Forgings. Moore Drop Forging Co. A very attractive 24-page catalog pictorially describes how drop forgings are made, and all the facilities for making them. (3-519)

Metal Forging. Steel Improvement & Forge Co. (3-409)

METAL PARTS

Flexible Metal Hose. Chicago Metal Hose Corp. A complete line of flexible metal hose, available in galvanized steel, bronze and other alloys, is presented in a 12-page, illustrated folder. Specifications are included. (3-515)

Gears. Fairfield Mfg. Co. This 16-page bulletin profusely illustrates and describes 27 different gears, and gear sets, made to order, including spiral bevel gears and pinions, worms and worm wheels, spur gears, etc. (3-514)

Wire D Rings. E. H. Titchener & Co. Standard shapes and sizes of wire D rings for metalware, electrical devices, etc. are illustrated and specifications given in a 2-page bulletin. (3-508)

Electrical Contacts. Gibson Electric Co. (3-76)

General Purpose Bearings. Johnson Bronze Co. (3-245)

Precision Bearings. Miniature Precision Bearings. (3-504)

Covers for Ball and Roller Bearings. R-S Products Corp. (3-192)

NON-METALLICS

Non-Metallic Materials. Continental-Diamond Fibre Co. Six non-metallic basic materials, namely Diamond vulcanized fibre, Dilecto, Dilectine, Celeron, Micabond and Vulcoid, are discussed in a 12-page, illustrated bulletin. Properties and recommended uses are included. (3-516)

Vibration Mounts. Hamilton Kent Mfg. Co. Greater vibration insulation through the use of Rexon vibration mounts is discussed in an 8-page, illustrated bulletin. (3-521)

Plywood Tubing. Plymold Corp. A reprint of an article on Plytube, a lightweight plywood tubing for use in structures, containers, pipe lines, etc., is presented in a 4-page, illustrated bulletin. (3-509)

Plastics. Chemaco Corp. (3-502)

Plastic Laminate. Continental Can Co. (3-475)

Silica Glass for High Temperatures. Corning Glass Works. (3-453)

Plastic Pipe. Dow Chemical Co., Plastics Div. (3-356)

Plastics. Durez Plastics & Chemicals, Inc. (3-235)

Plastic Data Book. Formica Insulation Co. (3-210)

Designing Plastics. General Electric Co. (3-244)

Industrial Rubber Products. B. F. Goodrich Rubber Co. (3-488)

Plastic Custom Molding. Imperial Molded Products Corp. (3-389)

Negative Temperature Coefficient Resistance Material. Keystone Carbon Co. (3-217)

Molded Plastic Products. Plastic Manufacturers, Inc. (3-430)

Plastics. Richardson Co. (3-403)

Liquid Plastic. U. S. Stoneware Co. (3-503)

Ceramic Plastics. Westinghouse Electric & Mfg. Co. (3-236)

POWDER METALLURGY

(See also Sec. 2—Special Metals; Sec. 3—Metal Parts; and Sec. 8—Metal Powder Processing)

Powder Metal Bearings and Parts. Chrysler Corp., Amplex Div. (3-473)

Powder Metallurgy Parts. Moraine Products Div., General Motors Corp. (3-139)

TUBING

Hot Workability of Steel for Tubes. Globe Steel Tubes Co. Bulletin No. 111 is an 8-page, illustrated reprint of an article on an elevated temperature, high-speed torsion test for testing the hot workability of steels. (3-510)

Heavy-Wall Tubing. Summerill Tubing Co. A one-page reprint discusses special tubing for heavy-wall sections, which withstands pressures as high as 140,000 p.s.i. (3-520)

Piping. Flori Pipe Co. (3-345)

OTHER METAL FORMS

Springs and Wire Forms. Wickwire Spencer Steel Co. Complete data on compression and extension helical springs, torsion springs, formed wires, spring wires, etc., are presented in a 28-page, illustrated catalog. Specifications are included. (3-517)

Weldments. Graver Tank & Mfg. Co., Inc. (3-425)

Magnet Steels. Indiana Steel Products Co. (3-340)

Spinning Equipment. Milwaukee Metal Spinning Co. (3-315)

Woven Wire Screen and Cloth. Newark Wire Cloth Co. (3-507)

4. Melting • Refining • Casting

AUXILIARIES

Plaster Molding. Castings Patent Corp. This 12-page, pocket-size booklet presents a reprint of a paper discussing several proposed basic considerations essential to the accurate control of heat dissipation in the casting of non-ferrous metals. (4-219)

Testing of Foundry Sands, Cores, Etc. H. W. Dietert Co. The testing and control of foundry sands, cores and coated materials with the Hitemp Dilatometer is discussed in a 4-page, illustrated bulletin. Specifications are included. (4-221)

Core Coating, Binder. Foundry Rubber Compounds Corp. (4-215)

MELTING FURNACES, MACHINES AND PARTS

Open-Hearth Furnace. Day & Zimmermann, Inc. This 16-page booklet contains an interesting reprint of an article on the cross-fired open-hearth furnace, which reduces the melt-down period, gives longer life to the brick work, etc. (4-224)

Melting Furnace Accessories. Fisher Furnace Co. This 20-page, illustrated catalog, No. 600, presents complete data on melting furnace accessories, including combustion controls, pyrometers, gages, etc. Specifications are included. (4-220)

> *In this Manufacturers' Literature INDEX, new bulletins are given complete reviews, and previously described older bulletins are merely listed in their proper places.*

Die Casting Machine. H. L. Harvill Mfg. Co. A new high-production cold chamber die casting machine for die casting aluminum, magnesium and bronze alloys is described and illustrated in a 20-page bulletin. (4-222)

Die Casting Machines. Lester-Phoenix, Inc. A variety of high-pressure die casting machines are described and illustrated in an 8-page, pocket-size folder. (4-223)

High Frequency Furnaces. Ajax Electrothermic Corp. (4-60)

Melting Furnaces. Campbell-Hausfeld Co. (4-79)

Rocking Electric Furnaces. Detroit Electric Furnace Div., Kuhlman Electric Co. (4-52)

Electric Melting Furnaces. Pittsburgh Lectromelt Furnace Corp. (4-61)

Electric Melting Furnaces, Top Charging. Swindell-Dressler Corp. (4-71)

5. Heating • Heat Treatment

ATMOSPHERES AND GENERATORS

Anhydrous Ammonia. Barrett Div., Allied Chemical & Dye Corp. Complete data on anhydrous ammonia are presented in an illustrated, 16-page booklet. Charts and diagrams are included. (5-569)

Bright Annealing of Metals. Lindberg Steel Treating Co. An attractive, 12-page bulletin discusses the bright annealing of ferrous and non-ferrous metals, and illustrates results of this process. (5-576)

Heat Treating with Ammonia. Pennsylvania Salt Mfg. Co. Complete data on heat treating with anhydrous ammonia are presented in a 16-page illustrated folder. (5-577)

SO_2 in Magnesium Industry. Ansul Chemical Co. (5-379)

Anhydrous Ammonia. Armour Ammonia Works. (5-435)

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Atmosphere for Treating Metals. Drever Co. (5-220)

Protective Atmosphere Furnaces. Hevi-Duty Electric Co. (5-449)

Drying Air or Gases. Pittsburgh Lectrodryer Corp. (5-500)

AUXILIARIES

Pressed Steel Pots. Eclipse Fuel Engineering Co. (5-352)

Electric Heat. General Electric Co. (5-405)

Cold Temperature Processing. Kold-Hold Mfg. Co. (5-406)

Cold-Treating Equipment. Motor Products Corp., Deep-Freeze Div. (5-410)

BATHS AND COMPOUNDS

Neutral Baths. A. F. Holden Co. Interesting data on neutral baths for hardening and tempering are presented in a 32-page, illustrated bulletin, No. 120. (5-582)

Heat-Treat Process. Ajax Electric Co., Inc. (5-543)

BLOWERS AND COMPRESSORS

Turbo Compressors. Spencer Turbine Co. (5-335)

BURNERS

Controlled Flame Temperatures. Bloom Engineering Co. Tempered-Flame burners for controlled heating and cooling cycles are described in a 4-page bulletin, No. 1220-5. Specifications, and diagrams are included. (5-570)

Gas Burners and Combustion Equipment. Burdett Mfg. Co. (5-534)

ELECTRICAL HARDENING AND HEATING

High Frequency Heating Equipment. Ecco High Frequency Corp. A variety of high frequency heating equipment, including generators, induction furnaces, crucibles, furnaces, etc., are described and illustrated in a 16-page booklet. Specifications are included. (5-581)

Electric Forging Heaters. American Car & Foundry Co. (5-23)

FURNACES

Blowerless Furnaces. Baker & Co., Inc. Small gas-fired furnaces that obtain high temperatures without the use of either blower or compressed air, for the heat treatment of high-speed steel, bright annealing, etc., are described and illustrated in an 8-page booklet. (5-574)

Furnaces. Barkling Fuel Engineering Co. Several Multi-Purpose furnaces for heat treating, hardening, annealing, carburizing, etc. are described and illustrated in a 4-page folder, No. 104. Prices are included. (5-580)

Electric Furnace. Harper Electric Furnace Corp. Bulletin No. 1044, two pages, describes and illustrates Model HS-667-P.I. inverted pit type electric furnace, either floor- or bench-type, with a temperature range of 1500 to 2950 F. Specifications are included. (5-579)

Carbon Correction Furnace. Lithium Co. The replacement of carbon in decarburized steel, by the Lithcarb selective carbon correction process is discussed in a 4-page, illustrated bulletin. (5-573)

Rotary Carburizing Furnaces. W. S. Rockwell Co. Complete data on the advantage, construction features and specifications of rotary carburizing furnaces, either oil, gas or electric, are presented in a 4-page, illustrated bulletin, No. 412. (5-572)

Pot Furnaces. Surface Combustion Div., Gen. Properties Co., Inc. Bulletin No. PG-43, four pages, describes and illustrates the design features of standard rated pot furnaces, available with either circular or rectangular pots, in 38 standard sizes, for heat treating steel parts. (5-571)

Furnace Periodical. Chicago Flexible Shaft Co. (5-291)

Rotary Forging Furnaces. George J. Hagan Co. (5-265)

Heat Treating and Laboratory Furnaces. K. H. Huppert. (5-303)

Heat-Treat Furnace. Lindberg Engineering Co. (5-403)

Heat Treating Furnaces. Salem Engineering Co. (5-341)

Induction Heating Units. Van Norman Co. (5-396)

OVENS

Heating Equipment. Harold E. Trent Co. A variety of electrically-heated ovens, heaters, furnaces, autoclaves, etc. are described and illustrated in a 4-page bulletin, No. 45-TB. (5-578)

PROCESSES

Sub-Zero Treatment for Tools. Alfred Heller Heat Treating Co. Announcement of a sub-zero treatment for a variety of high-speed tools and many other tool steels is made in a 4-page folder. (5-575)

Surface Hardening. Chapman Valve Mfg. Co. (5-149)

6. Refractories • Insulation

Refractories. Harbison-Walker Refractories Co. An attractive, 8-page bulletin describes and illustrates H-W refractories of highest quality flint and plastic clays, as well as insulating fire brick and high-temperature bonding mortars. (6-173)

Fire Clays. Illinois Clay Products Co. Each step in the manufacture of Goose Lake fire clays is pictorially portrayed in a 4-page bulletin. (6-174)

Plastic Refractory. Ironton Fire Brick Co. "Ironton Nojoint," a plastic ramming refractory for furnace linings and repairs, is discussed in a single-page, illustrated reprint. (6-172)

Wet Bonding Mortar. M. W. Kellogg Co. Ignisite, an air-setting high temperature bonding mortar, shipped wet in steel drums, for bonding fire brick in annealing and heating furnaces, boilers, etc., is described in an illustrated, single sheet. (6-171)

Insulating Cement. Universal Zonolite Insulation Co. Complete data on Zonolite high-temperature insulating cement for application to practically any heated surface requiring insulation are presented in an 8-page, illustrated bulletin. (6-175)

Insulating Earth. Armstrong Cork Co. (6-121)

Refractory Coating Material. Brickseal Refractory Co. (6-67)

Masonry Saw. Clipper Manufacturing Co. (6-82)

Flux Resistant Refractory. Corhart Refractories Co. (6-95)

High Temperature Bonding Mortar. Laclede-Christy Clay Products Co. (6-87)

Insulating Casting Refractory. Plibrico Jointless Firebrick Co. (6-69)

7. Welding

BRAZING AND SOLDERING

Silver Alloy Brazing. Handy & Harman. The preplacing of Sil-Fos and Easy-Flo, in wire, rod, strip and sheet form, for low-temperature silver alloy brazing is discussed in *Low-Temperature Brazing News,* No. 29, four pages. (7-337)

Silver Brazing Alloy. Sherman & Co. Low-melting Nu-Braze Grade 6, a silver brazing alloy for high strength joints in metals and alloys, similar or dissimilar, ferrous and non-ferrous, is described in a 4-page, pocket-size booklet. (7-329)

Silver Flux. Scaife Co. (7-224)

ELECTRIC ARC WELDING

Arc Welders, Cranes, Etc. Harnischfeger Corp. Bulletin No. G2-2, 16 pages, describes and illustrates a variety of P & H equipment, including arc welders, cranes, hoists, welding positioners, welding electrodes, etc. (7-333)

Arc Welding. Hobart Brothers Co. A very attractive, 16-page booklet pictorially presents the "Simplified" method of arc welding steel. (7-330)

Welded Design. Lincoln Electric Co. Application Sheet No. 90, four pages, is one of a series describing and illustrating the welded design of sprocket drives, pin-wheel brackets and digging wheel lower trucks. (7-343)

Stud Welder. Nelson Specialty Welding Equipment Co. An automatic electric arc stud welder, for welding in down, overhead or horizontal position, is described and illustrated in a 4-page bulletin. (7-331)

Stainless Steel Welding. Arcos Corp. (7-103)

Arc Welding Accessories. General Electric Co. (7-188)

Stainless Electrodes. McKay Co. (7-174)

Arc Torch. Mid-States Equipment Co. (7-251)

FLAME-PROCESSING

Flame Cutting. Central Boiler & Mfg. Co. The advantages of flame cutting over friction cutting methods are presented in a 4-page, illustrated bulletin. (7-345)

GAS WELDING

Welding Torch Tips Cleaner. Wolfe-Kote Co. Tip Cleen, a new cleaner for welding torch tips that is non-injurious to the tips, is discussed in a one-page bulletin. (7-328)

RESISTANCE WELDING

Seam Welder Controls. General Electric Co. Complete data on electronic seam-welder controls for resistance-welding machines are presented in a 12-page, illustrated bulletin, No. GEA-4220. (7-335)

Welding Electrodes and Alloys. P. R. Mallory & Co., Inc. A complete line of standard spot welding electrodes and water-cooled holders is presented in a 32-page, illustrated catalog. Stock sizes, applications and physical properties are included. (7-342)

Resistance Welding Applications. Progressive Welder Co. An attractive, 60-page catalog, No. WP-44, profusely illustrates and describes every general type of resistance welding, including single or multiple, spot, seam or flash, butt or projection welding. (7-332)

SUPPLIES

Arc Welding Electrodes. Allis-Chalmers Mfg. Co. Complete data on a line of a.c. and d.c. arc welding electrodes, including the physical properties of weld metal and recommended current values, are presented in a 16-page, pocket-size, illustrated booklet, No. L6348. (7-338)

Aluminum Bronze Rod. Ampco Metal, Inc. Engineering Data Sheet No. 128, one page, discusses a sub-assembly welded with Ampcotrode, an aluminum bronze alloy. Illustrations are included. (7-334)

Welding Electrodes. Page Steel & Wire Div., Am. Chain & Cable Co., Inc. Detailed information on Page-Allegheny stainless steel welding electrodes is given in a new bulletin. (7-340)

Fluxes for Welding, Brazing, Etc. Superior Flux Co. A complete line of Superior fluxes for welding, brazing, silver soldering, soft soldering, and low-temperature alloy welding is discussed in an 8-page bulletin, No. 44. Prices are included. (7-341)

Electrode Holders, Etc. Tweco Products Co. A complete line of cable connections for electric welding, including plain and insulated electrode holders, ground clamps, cable connectors and lugs, etc., is described and illustrated in a 12-page bulletin. Specifications and prices are included. (7-336)

Welding Electrodes. Welding Equipment & Supply Co. A complete line of Eureka tool and die welding electrodes is presented in a 40-page catalog. (7-344)

Ground Clamp. Will-Weld Mfg. Co., Inc. This single page describes and illustrates the E-Z ground clamp, of solid copper alloy construction, for increasing efficiency when welding. (7-339)

Welding Positioner. Cullen-Friestedt Co. (7-68)

Welding Electrodes. A. O. Smith Corp. (7-261)

8. Metal-Working

FORMING

Power Presses. Clearing Machine Corp. An attractive, 16-page bulletin describes and illustrates the facilities of this company for producing power presses, and presents post-war plans. (8-581)

Hydraulic Presses. Charles E. Francis Co. Bulletin No. L-2, four pages, describes and illustrates cold hydraulic presses for all types of laminated work for plastics, metal, plywood, etc. (8-575)

Die and Mold Duplicators. George Gorton Machine Co. Three models of die and mold duplicators for production profiling and duplicating all kinds of dies and molds for plastics, rubber, etc., are described and illustrated in a 12-page bulletin, No. 1319-D. Specifications are included. (8-557)

Automatic Tubing Machine. Leonard Precision Products Co. The 3CP Tube Master, an automatic machine for squaring, flaring, burring and beading ferrous or non-ferrous tubing, is described and illustrated in a 4-page bulletin. (8-587)

Metal Duplicating Without Dies. O'Neil-Irwin Mfg. Co. The Di-Acro method of metal duplicating without dies, called Die-Less Duplicating, is discussed in a 4-page, illustrated bulletin. (8-561)

Automatic Benders. Pines Engineering Co., Inc. Series 100 automatic benders, with finger-tip push button control, for pipe, tubing bar stock, etc., are described and illustrated in an 8-page bulletin. (8-586)

Cable Swagers. Standard Machinery Co. Bulletin No. CS, four pages, describes and illustrates Standard cable swaging machines and component parts. Specifications are included. (8-566)

Tangent Bender. Struthers-Wells Corp. The many applications of the SW tangent bender, adaptable to every industry where difficult sheet metal working is required, are profusely illustrated and described in an 8-page bulletin, No. 53-T. (8-559)

Hole Punching System. Wales-Strippit Corp. The type "CD" hole punching system, made up of hole punching units, templates, locator rings, adjustable stops, feed rails and drill templates, is described in a 32-page, illustrated catalog, No. CD. (8-564)

Hydraulic Equipment. Watson-Stillman Co. A comprehensive line of hydraulic equipment for the process industries, including hydraulic presses, pumps and accumulators, as well as forged steel fittings and valves, is presented in an 8-page bulletin, No. 130-A. (8-572)

Pipe and Tube Mill Equipment, Etc. Aetna-Standard Engineering Co. (8-555)

Hydraulic Presses. Anderson Bros. Mfg. Co. (8-279)

Double-Flaring Tool. Imperial Brass Mfg. Co. (8-348)

Sheet Metal Facilities. Kirk & Blum Mfg. Co. (8-333)

Hydraulic Presses. Lake Erie Engineering Corp. (8-248)

Vertical Punches. Thomas Machine Mfg. Co. (8-539)

Hydraulic Presses. A. B. Farquhar, Ltd. (8-146)

MACHINING

Clamps and Cylinders. Airop Inc. A few typical applications of Airop damps and cylinders used on milling machines and in riveting, welding, drilling and reaming operations are described and illustrated in a 6-page folder. Prices are included. (8-584)

Special Steel Drills. Black Drill Co., Div. Black Industries. "Hardsteel" drills for drilling steel hardened by any method to any hardness are described and illustrated in a 24-page bulletin. Recommended drilling speeds, correct procedure for wet and dry drilling, applications and specifications are included. (8-582)

Surface Grinder. Builders Iron Foundry. This 6-page, pocket-size folder describes and illustrates a versatile "T" surface grinder, available with either bench or floor mountings, for production and odd job grinding. Specifications are included. (8-576)

Hydraulic Broaching Presses. Colonial Broach Co. A variety of "Junior" hydraulic presses for light- and medium-duty assembly and broaching work are described and illustrated in a 4-page bulletin, No. VJ 1-44. (8-571)

Metal Disintegrator. Drafto Corp. The Drafto metal disintegrator, a revolutionary method for removing embedded tools, is described and illustrated in a 4-page bulletin. (8-568)

Please Use the Coupon on Page 241

Coolant Cutting Compound. Finegan-Campbell Co. This 4-page folder presents complete data on INSTA, a wax form of coolant cutting compound for use with hand-operated tools in drilling, machining and threading all metals. (8-558)

Utility Sleeve Tool Driver. J. C. Glenzer Co. This 4-page bulletin describes and illustrates a utility sleeve tool driver for use with drills, taps, reamers, end mills, etc. Prices are included. (8-577)

Hydraulic Surface Grinder. Hill Acme Co. This one-page leaflet describes and illustrates the Hill "Open Side" horizontal spindle hydraulic surface grinder for close tolerance grinding of joint faces. (8-570)

Semi-Steel Chuck. Ideal Commutator Dresser Co. A "Universal" chuck, furnished with a set of internal and external jaws, are described and illustrated in a 2-page bulletin. (8-565)

Diamond Wheels. Industrial Abrasives, Inc. This 16-page folder describes and illustrates a complete line of Super-cut zurium-bonded diamond wheels for wheel and thread dressing, gear grinders, turning and boring, etc. (8-578)

Tool Grinders. K. O. Lee Co. This 12-page, illustrated bulletin presents a complete list of companies throughout the states who use Universal tool grinders and carbide tool grinders. (8-556)

Grinding and Finishing. Minnesota Mining & Mfg. Co. The 3-M method for high-speed grinding and finishing is described in a 12-page, illustrated bulletin. (8-583)

Air-Powered Machines, Etc. Myers Engineering Co. This 4-page bulletin describes and illustrates a variety of air-powered, electrically controlled machines, jigs and fixtures for special purpose drilling, tapping and punching. (8-560)

Metal-Cutting Tools. Putnam Tool Co. A complete line of Hi-speed metal-cutting tools, including end mills, reamers, counterbores, etc., is described and illustrated in a 92-page catalog. Specifications and prices are included. (8-585)

Shankless Drill. Republic Drill & Tool Co. Complete data, including specifications and prices, on a new Shankless high-speed roll-forged twist drill are presented in a 40-page, illustrated catalog. (8-569)

Torque Tools. Richmont, Inc. Sixty models and sizes of Livermont Torq-Stop tools for proper torquing during manufacture and assembly is described and illustrated in a 12-page bulletin. Specifications are included. (8-579)

Cutting Fluids. D. A. Stuart Oil Co. Extensive data on the selection and use of cutting and grinding fluids, as well as on steels, machinability, hardness, tools, etc. are presented in a 60-page, illustrated booklet. Specifications and numerous tables are included. (8-580)

Carbide Tools and Blanks. Vascoloy-Ramet Corp. This 10-page, illustrated bulletin, No. VR-330, presents a new, revised price list of a complete line of tantalum-tungsten carbide tools and blanks. Specifications are included. (8-563)

Machining Aluminum. Aluminum Co. of America. (8-171)

Hardfacing Tool Electrodes. American Agile Corp. (8-212)

Quick Analysis of Tapping Troubles. Henry P. Boggis & Co. (8-541)

Grinding Data Book. Carborundum Co., Refractory Div. (8-544)

Grinding Wheels. Cleveland Quarries Co., Sterling Grinding Wheel Div. (8-257)

Gear Hobs. Colonial Tool Co., Ltd. (8-547)

Oil Filters. Cuno Engineering Corp. (8-108)

Cutting Steels. General Aircraft Equipment, Inc., Metoloy Div. (8-244)

Portable Coolant Systems. Gray-Mills Co. (8-364)

Cutting Tools and Gages. Greenfield Tap & Die Corp. (8-485)

Cutting Oil. Gulf Oil Corp. (8-141)

Finishing Machines. Hammond Machinery Builders. (8-296)

Tools. Kenmetal, Inc. (8-190)

Grinding Wheels. Larco Diamond Tool Co. (8-444)

Eccentric Drive Counterbores, Etc. Moreland Tool Co. (8-540)

Wheel and Tool Former. W. F. Myers Co., Inc. (8-543)

Metal Cutting Machine. Racine Tool & Machine Co. (8-389)

Precision Grinding Wheels. Universal Wheel & Abrasive Corp. (8-377)

ROLLING

Solid Steel Shear Knives. Heppenstall Co. (8-224)

METAL POWDER PROCESSING

Presses for Metal Powder Products. E. W. Bliss Co. This 20-page bulletin profusely illustrates a variety of presses for the processing of metallic and related powders. (8-573)

Presses for Powder Metallurgy. Hydraulic Press Mfg. Co. Bulletin No. 4406, eight pages, describes and illustrates Fastraverse hydraulic presses for powder metallurgy, and includes specifications. (8-574)

Cone Blender. Patterson Foundry & Machine Co. (8-493)

Mixers, Agitators, Etc. H. K. Porter Co., Inc. of Pittsburgh, Pa. (8-542)

RIVETING AND FASTENING

Lock-Nuts. Columbia Nut & Bolt Co., Inc. Improved "Columbia" lock-nuts for use on all kinds of machinery, conveyors and equipment are described and illustrated in a 4-page bulletin. (8-567)

Explosive Rivets. E. I. duPont de Nemours & Co., Inc. Helpful data, instructions and technical information on high-speed blind riveting with explosive rivets are presented in a new manual. (8-562)

9. Cleaning • Finishing

CLEANING

Cleaning of Die Castings. Oakite Products, Inc. A digest of cleaning materials and methods for the surface preparation of die castings before subsequent finishing operations is presented in a 12-page bulletin. (9-488)

Batch Cleaning. Optimus Equipment Co. Bulletin No. 4E2, four pages, describes and illustrates methods of batch cleaning in portable metal washing machines, for production, maintenance and repair. (9-483)

Cleaning Machines. Alvey-Ferguson Co. (9-317)

Dust Collecting Equipment. Peters-Dalton, Inc. (9-184)

Surface Peening. W. W. Sly Mfg. Co. (9-422)

Abrasive Cleaning. Vapor Blast Mfg. Co. (9-166)

CHEMICAL TREATMENTS

Hot Dip Tanks. Aeroil Burner Co., Inc. A variety of insulated hot dip tanks, electrically heated with thermostatic controls, for metal cleaning, degreasing, rust-proofing, etc., are described and illustrated in a 16-page bulletin. Specifications are included. (9-490)

Zinc Finish. Chemical Corp. Luster-on, a new inhibited zinc bright dip for producing chromium brilliancy on dull zinc surfaces, is discussed in a 4-page, illustrated bulletin. (9-489)

Fingerprint Neutralizer. E. F. Houghton & Co. The Cosmoline fingerprint neutralizer, a combination of rust preventive, cleaner and neutralizing agent, which neutralizes acid deposits on steel parts formed by fingerprints, is discussed in a 4-page, illustrated bulletin. (9-485)

ELECTROPLATING

Plating Equipment. Belke Manufacturing Co. (9-473)

Selenium Rectifiers. Federal Telephone & Radio Corp. (9-442)

NON-METALLIC AND ORGANIC COATINGS

Plastic Coating. American Pipe & Construction Co. Amercoat No. 23, a plastic coating suitable for immersion in a wide variety of acids, salts, alkalies, etc., for preventing corrosion, is discussed in a 4-page bulletin. (9-486)

Infrared Radiant Energy. Fostoria Pressed Steel Corp. Infrared radiant energy for baking, drying, preheating and dehydrating, and the Evenray System equipment for accommodating a wide range of infrared radiant energy sources, are discussed in an 8-page, illustrated bulletin. (9-484)

Protective Coatings. Quigley Co., Inc. A complete line of Triple-A industrial paints that protect iron, steel, wood, brick, etc. against rust and corrosion is presented in a 24-page, illustrated booklet. (9-481)

Spray Finishing Systems. Binks Mfg. Co. (9-362)

Wax Over Black Oxidizing Finishes. S. C. Johnson & Son, Inc. (9-179)

Preserving Steel with Paint. New Jersey Zinc Co. (9-268)

Rust Preventive. Nox-Rust Corp. (9-348)

Rust Arresters. Smith Oil & Refining Co., Industrial Oils Div. (9-377)

Spray Finish Machines. Spray Engineering Co. (9-182)

PICKLING

Standard Pickling Control. American Chemical Paint Co. Technical Service Data Sheet No. 13-1, four pages, describes and illustrates Rodine, a standard control for the pickling bath. (9-482)

Corrosion Resistant Ceramics. Atlas Mineral Products Co. (9-72)

Chemicals in Metal Industry. Monsanto Chemical Co., Merrimac Div. (9-193)

POLISHING

Compress Polishing Wheels. Divine Brothers Co. Complete data on Compress polishing wheels for practically every class of abrasive metal finishing from roughing to the finest polishing are presented in a 6-page, illustrated folder. (9-480)

Deburring and Finishing Metal Parts. Sturgis Products Co. The Roto-Finish method of grinding, deburring, polishing, honing and coloring of metal parts and castings is discussed in a 4-page, illustrated bulletin. (9-487)

10. Testing • Quality Control

CONTROL INSTRUMENTS

Air Operated Controller. Askania Regulator Co. Bulletin No. 120, four pages, describes and illustrates a new air operated controller that employs hydraulic operation to control heavy valves and dampers. (10-587)

Air Controllers. Bellows Co. This folder is a unique presentation in the form of 25 photographs, showing installation of all types of controlled air devices and accessories, plus a complete story of each application and list prices. (10-602)

Electrical Resistance Recorder. Foxboro Co. This 40-page catalog presents complete data on the Dynalog electronic recorder for measuring and recording electrical resistance or capacitance. Numerous diagrams are included. (10-600)

Tachometers. Jones Motrola Co. A variety of individual-mount tachometers and a multi-range portable hand tachometer are described and illustrated in a 6-page pocket-size folder, No. 44-1. A price list is included. (10-591)

Electric Control for Salt Pots. Leeds & Northrup Co. Micromax electric control, a duration-adjusting type, for maintaining constant temperature of electrically-heated salt pots is discussed in an 8-page bulletin, No. N-33B-621 (1). (10-597)

Electric Timers. Paragon Electric Co. Eight improvements in a variety of automatic electric timers are listed in a 4-page, illustrated bulletin, No. 4492. (10-605)

Shielded Pressure Tubes. Revere Co. A variety of directionally shielded, total pressure tubes for accurate measurement of pressure in air and fluids where the direction of flow is questionable are described and illustrated in a 4-page bulletin. (10-590)

Control Instrument. Wheelco Instruments Co. The Rheotrol, a device to maintain a desired electric power or heat input, or flow of liquids or gases to any process or equipment, is described and illustrated in a 2-page bulletin, No. J303-2. Specifications are included. (10-589)

Micro Pressure Switches. Barber-Colman Co. (10-418)

Direct-Reading Dilatometer. Bristol Co. (10-514)

Control Systems for Forging Furnaces. Brown Instrument Co. (10-247)

Combustion Control. Cities Service Oil Co. (10-518)

Regulators. Victor Equipment Co. (10-463)

HARDNESS TESTING

Blast Furnace Snort Valve. Wm. M. Bailey Co. This 2-page bulletin illustrates the 42-in. butterfly and 18-in. snort valve for use in blast furnaces. (10-592)

Hardness Testers. Wilson Mechanical Instrument Co., Inc. A variety of Rockwell hardness tester models are described and illustrated in a 4-page bulletin, No. ER-4. (10-599)

Ferrous and Non-Ferrous Hardness Tester. Clark Instrument, Inc. (10-236)

Surface Finish Tester. Taber Instrument Co. (10-153)

INSPECTION DEVICES

Dial Indicators, Comparators, Etc. B. C. Ames Co. A new 56-page catalog, No. 53, lists a complete line of dial indicators, micrometers, comparators, gages, etc. (10-598)

Thread Gages. Cadillac Gage Co. A price list and sizes of Stellite thread plug and thread ring gages are presented in a 16-page, illustrated booklet. (10-595)

Illuminated Magnifiers. R. P. Cargille. Flash-O-Lens magnifiers, with built-in lighting units, for 7X, 20X and 40X magnifications, are described and illustrated in a 2-page folder. Prices are included. (10-603)

Scales. Detecto Scales, Inc. Catalog No. 643, 36 pages, describes and illustrates a complete line of scales, and includes specifications and prices. (10-596)

Counting Scales. Howe Scale Co. A variety of counting scales, including a double-ratio scale with a special third pan for counting small parts, are described in a new bulletin, No. P-1. (10-604)

Dynamics Measurement Equipment. Glenn L. Martin Co. This 4-page bulletin describes and illustrates dynamics measurement equipment for determining acceleration, loads and stresses of aircraft. (10-601)

Precision Gages. Continental Machines, Inc. (10-533)

Indicator Snap Gage. Federal Products Corp. (10-574)

Magnaflux Inspection. Magnaflux Corp. (10-248)

Identification of Steel. Dravo Corp. (10-271)

Balancing Machines. Tinius Olsen Testing Machine Co. (10-429)

Measuring Surface Roughness. Physicists Research Co. (10-582)

MECHANICAL TESTING

Testing Machines. Riehle Testing Machine Div., Am. Machine & Metals, Inc. This 8-page bulletin profusely illustrates and describes a variety of Universal precision hydraulic testing machines and instruments for impact, tension, compression, transverse and hardness testing. (10-593)

Testing Machine. Air Reduction Co. (10-554)

Testing Laboratory. F. A. Pease Laboratories. (10-585)

Strain Gage. Baldwin-Southwark Div. (10-314)

METALLOGRAPHIC EQUIPMENT

Metallurgical Laboratory Equipment. Buehler, Limited. (10-199)

RADIOGRAPHY

Film Dryer. Pako Corp. This four-page bulletin describes and illustrates a new Infray-tube dryer and dries X-ray, roll and cut films and film pack thoroughly and uniformly without any light damage. Specifications are included. (10-588)

X-Ray Films. Ansco. (10-315)

Industrial X-Ray Units. General Electric X-Ray Corp. (10-324)

X-Ray Inspection Tool. North American Philips Co., Inc. (10-536)

X-Ray Equipment. Picker X-Ray Corp. (10-537)

SPECTROGRAPHY

Universal Spectrophotometers. Wilkens-Anderson Co. (10-180)

LABORATORY AIDS

Gas Analysis Equipment. Burrell Technical Supply Co. Typical new models of gas analysis equipment are described and illustrated, and prices of each listed in a 4-page bulletin, No. 446A. (10-594)

Laboratory Equipment. Central Scientific Co. (10-507)

11. Equipment and Machinery, General

Production Research. Battelle Memorial Institute. An attractive 56-page catalog discusses the activities of Battelle as a research center for industry on a non-profit basis. Numerous photographs graphically portray each application. (11-296)

Centrifugal Pumps. Bell & Gossett Co. A complete line of Type W centrifugal pumps is presented in a 40-page, illustrated catalog, No. CP-843. Engineering data and specifications are included. (11-304)

Pocket-Type Slide Rule. Charles Bruning Co., Inc. A new 5-in. pocket-type slide rule, No. 2401, which offers hairline accuracy plus maximum visibility, is described and illustrated in a 6-page, pocket-size pamphlet. (11-300)

Fans and Air Conditioning Equipment. Chelsea Fan & Blower Co., Inc. A complete line of industrial cooling and exhaust fans, humidifiers, air circulators, etc. is presented in a series of bulletins compiled into one catalog. (11-295)

Water Cooler. Drayer & Hanson, Inc. Strata-Flo water coolers, which eliminate warm-up, wet systems and control problems, are described and illustrated in a 16-page bulletin. Specifications are included. (11-291)

Linograph Transfer Paper. Eastman Kodak Co. Complete data on Kodak linograph transfer paper for sensitizing sheets of metal, plastic, wood, glass, etc. are presented in a handy, 20-page booklet. Prices are included. (11-293)

Induction Generators. Electric Indicator Co. "Elinco" drag cup induction generators, in both base- and frame-mounted models, are discussed in a single sheet. (11-301)

Adjustable Transformers. General Radio Co. Variac continuously adjustable transformers for voltage, speed, power, heat and light control are described and illustrated in a 4-page bulletin. Specifications and prices are included. (11-294)

Please Use the Coupon on Page 241

Oil Filters. Hilliard Corp. A variety of standard Hilco Hyflow oil filters for purifying oils used in hydraulic presses, compressors, heat treating machines, etc., are described and illustrated in an 8-page bulletin, No. HF. Specifications are included. (11-292)

Fans, Blowers, Etc. Ilg Electric Ventilating Co. This attractive, 8-page bulletin describes and illustrates a new laboratory for fan, blower and unit heater research. (11-303)

Hydraulic Equipment. Lyon-Raymond Corp. Bulletin No. 137 four pages, describes and illustrates a variety of hydraulically-operated material handling equipment, developed for specific applications. (11-299)

Distribution Boxes. Ohio Brass Co. The O-B type LG permissible distribution boxes, 250 and 550 v., d.c., for connecting several electrically-operated machines to one power source, are described and illustrated in an 8-page bulletin. Specifications are included. (11-302)

Processing Carriers. Rolock, Inc. A variety of specialized processing carriers, including crates, tanks, trays, baskets, etc., for heat treating, pickling, plating and finishing operations, are described and illustrated in a 24-page catalog. (11-297)

Corrosion Ratings of Metals. Westinghouse Electric & Mfg. Co. Numerous tables and a brief discussion of the corrosion resistance of various metals are presented in a series of eight pages. (11-298)

Colloidal Graphite. Acheson Colloids Corp. (11-108)

Dust Collectors. Aget-Detroit Co. (11-282)

Air Filtration. American Air Filter Co., Inc. (11-62)

Dust Collector. American Foundry Equipment Co. (11-196)

High Vacuum Pumps. Beach-Russ Co. (11-286)

Mounted Wheels for Portable Tools. Chicago Wheel & Mfg. Co. (11-70)

Magnetic Separators. Dings Magnetic Separator Co. (11-232)

Flexible Shafting for Packaging. Dow Chemical Co. (11-183)

Heat Exchangers. Downington Iron Works, Heat Transfer Div. (11-284)

Refrigeration and Air Conditioning Equipment. General Electric Co. (11-243)

Hydraulic Equipment. Hydraulic Machinery, Inc. (11-201)

Impregnating Castings. Jackson & Church Co. (11-222)

Variable Speed Drive. Lombard Governor Corp. (11-285)

Heat Exchangers, Etc. National Carbon Co., Inc., Carbon Products Div. (11-269)

After-Cooler. Niagara Blower Co. (11-287)

Dust Preventives. Parsons Engineering Corp. (11-233)

Water Softening. Permutit Co. (11-42)

Silicates. Philadelphia Quartz Co. (11-167)

Technical Books. Reinhold Publishing Corp. (11-273)

Centrifugal Blowers. Roots-Connersville Blower Corp. (11-102)

Lubrication for Steam Turbines. Sinclair Refining Co., Inc. (11-197)

Fans. Trane Co. (11-54)

Industrial Vacuum Equipment. Vacuum Engineering Div., National Research Corp. (11-280)

Electronic Supplies. Walker-Jimieson, Inc. (11-283)

Air Conditioning Equipment. Westinghouse Electric Elevator Co., Air Conditioning Div. (11-289)

The predictable, minimum distortion characterizing molybdenum carburizing steels helps reduce the cost of producing precision parts

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engineering NEWS

of the metal-working industries

These rather surprising developments are highly interesting as showing the broad extent to which these materials are being used in the war effort. It would be a satisfaction to know in just what applications the various types are used but some of this is probably a military secret. It would gratifying if the data on these

Electronic Timing for Uniform X-Ray Exposure

A photoelectric X-ray timing device now enables radiologists and technicians to obtain uniformly dense photofluorographic exposures with an overall increase in operating efficiency of 100%. The electronic timer, developed by the *Westinghouse Electric & Mfg. Co.*, times each exposure properly, quickly and automatically.

The timer, in effect, measures the light leaving the fluorescent screen on which the X-rays cast the object image. When sufficient light has left the screen for satisfactory film exposure, the photoelectric tube that scans the screen actuates a relay, opening the X-ray circuit and terminating the exposure.

Although first used in medical radiography for mass chest surveys on miniature roll films, the development promises to be generally useful, and will include industrial X-ray analysis. Whether similar objects, such as castings, are moving rapidly on a conveyor, or whether a variety of irregular objects must be X-rayed, the electronic timer will provide uniform exposures quickly and efficiently. The electronic timer takes advantage of the nature of the photoelectric tube whose output is proportional to the light striking the cathode.

The heart of the phototimer is the so-called phototube camera consisting of a lens that scans the fluorescent screen, a photoelectric multiplier tube, and a condenser—thyratron—relay system. The phototube camera is mounted beneath the photofluorographic hood and "sees" the object image on the screen, which is "seen" by the photographic camera at the apex of the hood. Light from the screen initiates a small current in the photoelectric tube, which is greatly amplified. The output current charges the condenser until the proper ionization voltage is reached, when the thyratron fires, actuating the relay that opens the X-ray circuit and terminates the exposure. Proper choice and design of circuit constants enable the timer to maintain the correct exposure factor for uniformly dense film exposures.

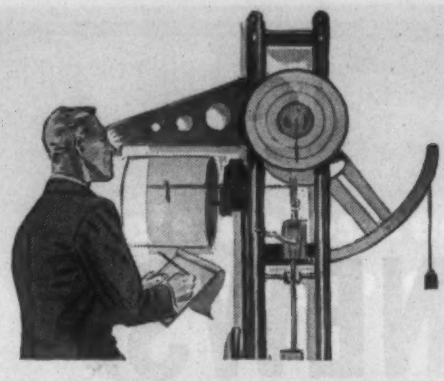
Until now, a major difficulty barring full utilization of the analytic capabilities of X-ray has been the lack of automatic exposure controls. The use of the new phototimer automatically assures a correct X-ray exposure, enabling the technician not only to double the number of exposures formerly made but to achieve better and more useful results as well.

In order to evaluate X-ray pictures accurately, it is important that the exposures be uniform in density and in what photographers call "contrast"—the sharpness of difference between the light and the dark areas.

X-rayed objects may vary not only in size and thickness but even in the degree to which X-rays are transmitted. These variables make it difficult to obtain uniform film exposures. Export technicians develop considerable skill in estimating X-ray penetration, but such evaluations and measurements are time-consuming and at best are only approximations. Therefore, even the best technician can only attain comparative uniformity of film exposures.

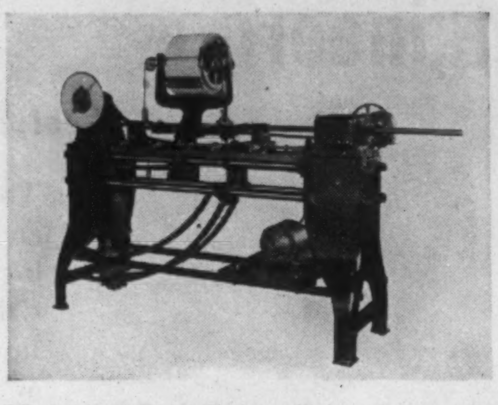
In the accompanying photograph the manager of engineering, X-ray division, checks the electrical circuit of the phototimer. The round object in the center of the box is a lens that focuses light from the X-ray activated fluorescent screen onto the phototube. The electric eye measures total quantity of this light and shuts off the X-ray tube when enough is "collected" to make a good photographic negative of the image.

● A new improved vise-wrench is announced by *Knu-Vise, Inc.,* Detroit 16. The milled teeth welded to the stamped body are made of heat-treated alloy steel forgings. The tool can be used as a portable vise to hold work for drilling, welding, riveting, soldering, grinding, etc. or as a pipe wrench. A locked grip on work can be maintained, leaving the worker's hands free. Normal hand grip can attain a clamping pressure at the jaws up to one ton. They are available in two sizes.



TESTING helps speed Reconversion

An adequate testing routine gives you the Control that speeds all the steps in reconversion—purchasing, research, production, acceptance-inspection. The 60 models of *Scott Testers are standard for tests on wire and strip from finest filament to 1 ton for tensile, hysteresis, twist, flexing, compression-cutting of rubber covering, etc.



Model Q-7 Scott Tester. Heavy duty tensile tester for wire with capacity of 2,000 lbs.

●

Request Bulletins

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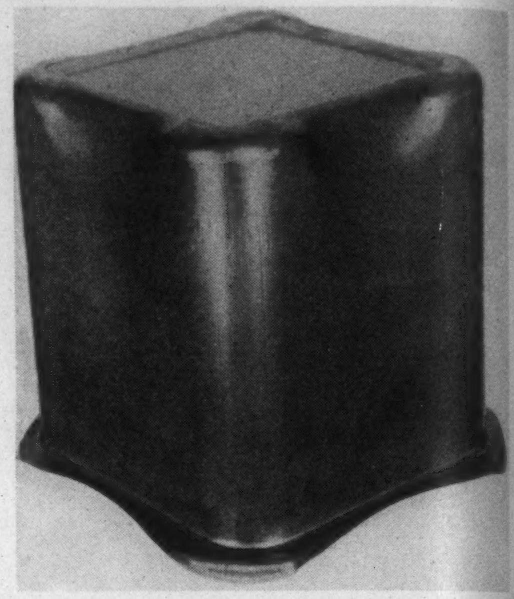
Vitreous Enameling Alloy Steel

The problem of successfully applying white or light pastel cover coat vitreous enamels directly to steel surfaces, to which an answer has been sought for years, has been solved through a new vitreous enameling alloy steel, the latest creation of the research laboratories of the *Inland Steel Co.*, 43 E. Ohio St., Chicago 11, Ill.

White and other colors of vitreous enamel can be applied directly to the new steel, known as "Inland Ti-Namel" steel, without the prior application of a base or ground coat enamel.



The achievement lies in the fact that a thinner covering of enamel produces a better surface, less liable to chip and with longer service life than the old, more costly multi-coat job.

The new alloy steel reduces enamel shop reoperation, edging and scrap. It permits a lower temperature and shorter time for firing. It increases shop output, and lowers overall enameling cost.

It is expected that this new alloy and process will cause vitreous enamel to be used far more extensively than ever before on many types of home equipment, such as refrigerators, washing machines, kitchen appliances, etc.

Previously, when enamels were applied without a ground coat directly to standard enameling stocks of former days, and fired, the resulting finishes were found to be full of black specks, enamel pits and enamel blisters, caused by gases, resulting from the reaction of carbon in the base metal with certain constituents in the enamel, when at firing temperature.

Inland, with the cooperation of the Titanium Alloy Mfg. Co., conducted research to prevent the formation of such gases and thus eliminate the black specks, enamel pits and blisters.

Titanium, when added in a quantity dependent upon the amount of carbon in the base of the metal, will eliminate the cause for pitting, black specking and blistering. The titanium combines with the carbon in the steel to provide titanium carbide, which is stable, and the titanium may also combine with the hydrogen entering the steel to form titanium hydride, also stable.

Indications are that the drawing properties of Inland Ti-Namel steel are fully

(Continued on page 250)

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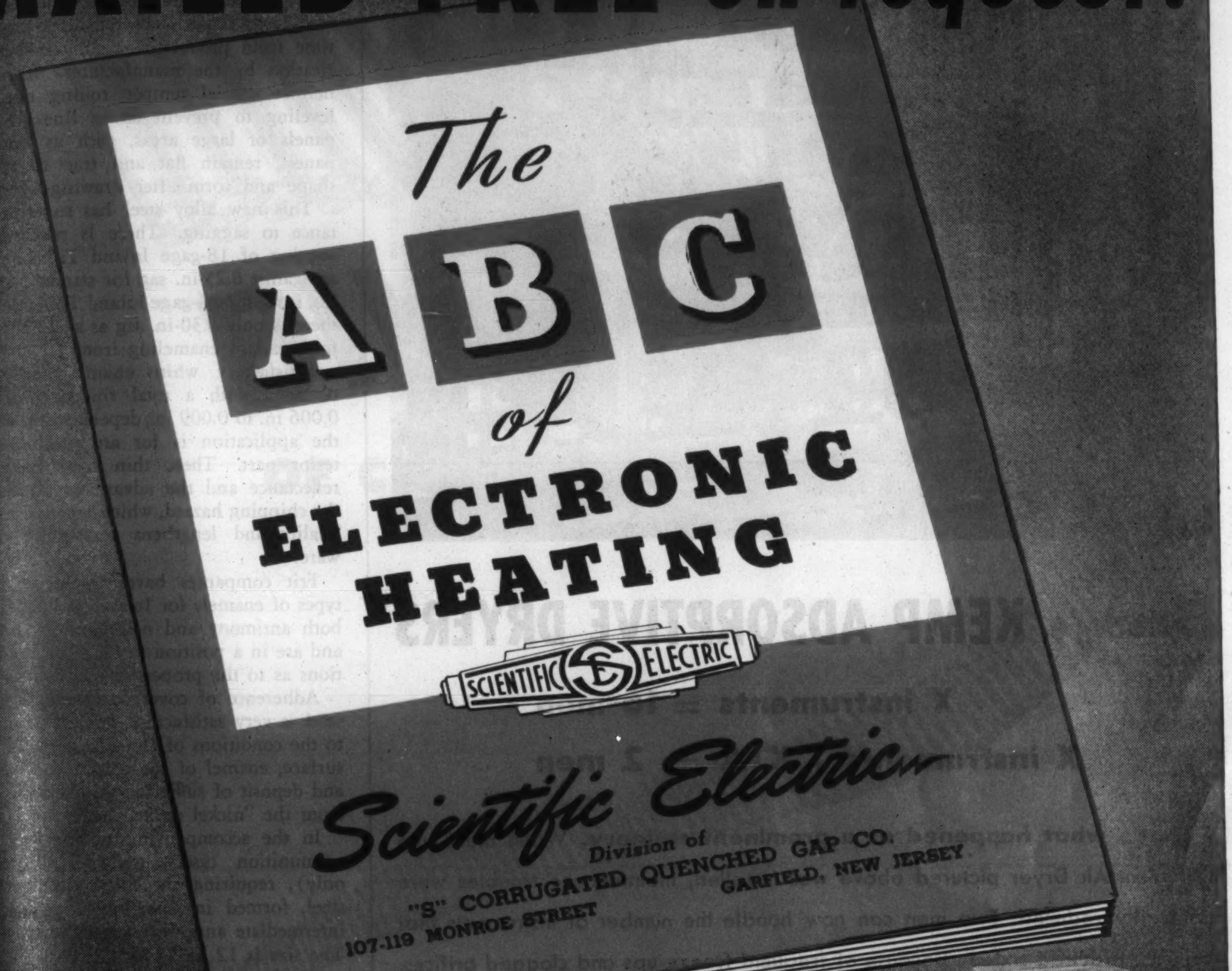

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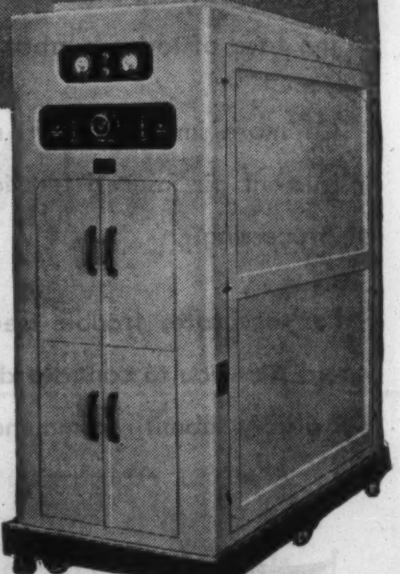

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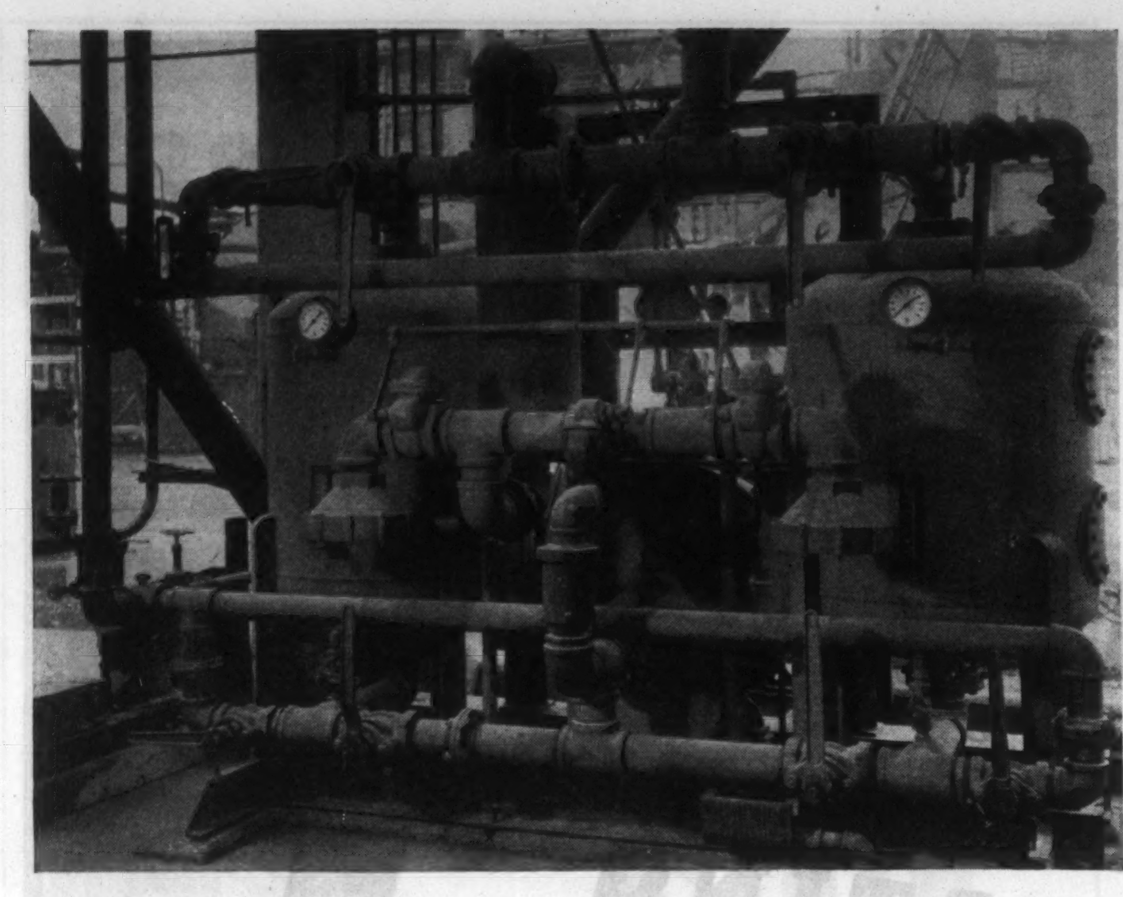

Specify **KEMP ADSORPTIVE DRYERS**

X instruments = 16 men

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That's what happened at a prominent refinery. When the Kemp Instrument Air Dryer pictured above was installed, maintenance troubles were materially reduced. Two men can now handle the number of instruments that formerly required sixteen because of frequent freeze-ups and clogged orifices. In the face of today's labor shortages that is important news!

Of more importance to refinery officals, however, **is the fact that DRY** instrument air insured functional instrumentation and gave them accurate control of processing.

For accurate, trouble-free instrumentation, specify KIA Dryers. In fact, it would pay you to consider drying all your compressed plant air—our engineers will gladly submit recommendations for your study.

Ask For Bulletin 25-C.

ARMY E NAVY

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equal to the best deep drawing iron and steel sheets, including the carbon steel sheets furnished to the automotive industry. It will permit drawing many parts heretofore formed and welded.

It does not age-strain. Drawn shapes are free from strain lines regardless of lapsed time from production by the mill to fabrication by the manufacturer. It requires neither special temper rolling nor roller leveling to prevent strain lines. Shallow panels of large areas, such as stove end panels, remain flat and true to required shape and form after drawing operations.

This new alloy steel has superior resistance to sagging. There is practically no sagging of 18-gage Inland Ti-Namel steel as against 0.25-in. sag for standard enameling iron; for 24-gage Inland Ti-Namel steel, there is only 0.30-in. sag as against 0.80 in. for standard enameling iron.

Satisfactory white enamel finishes are obtained with a total thickness of from 0.006 in. to 0.009 in., depending on whether the application is for an interior or exterior part. These thin coats have high reflectance and the advantage of reducing the chipping hazard, which greatly improves quality and lengthens service-life of the ware.

Frit companies have developed several types of enamels for Inland Ti-Namel steel, both antimony and non-antimony bearing, and are in a position to make recommendations as to the proper enamel to use.

Adherence of cover coat enamels to the steel is very satisfactory, subject principally to the conditions of cleanliness of the sheet surface, enamel of the correct composition, and deposit of sufficient thickness of nickel from the "nickel strike" bath.

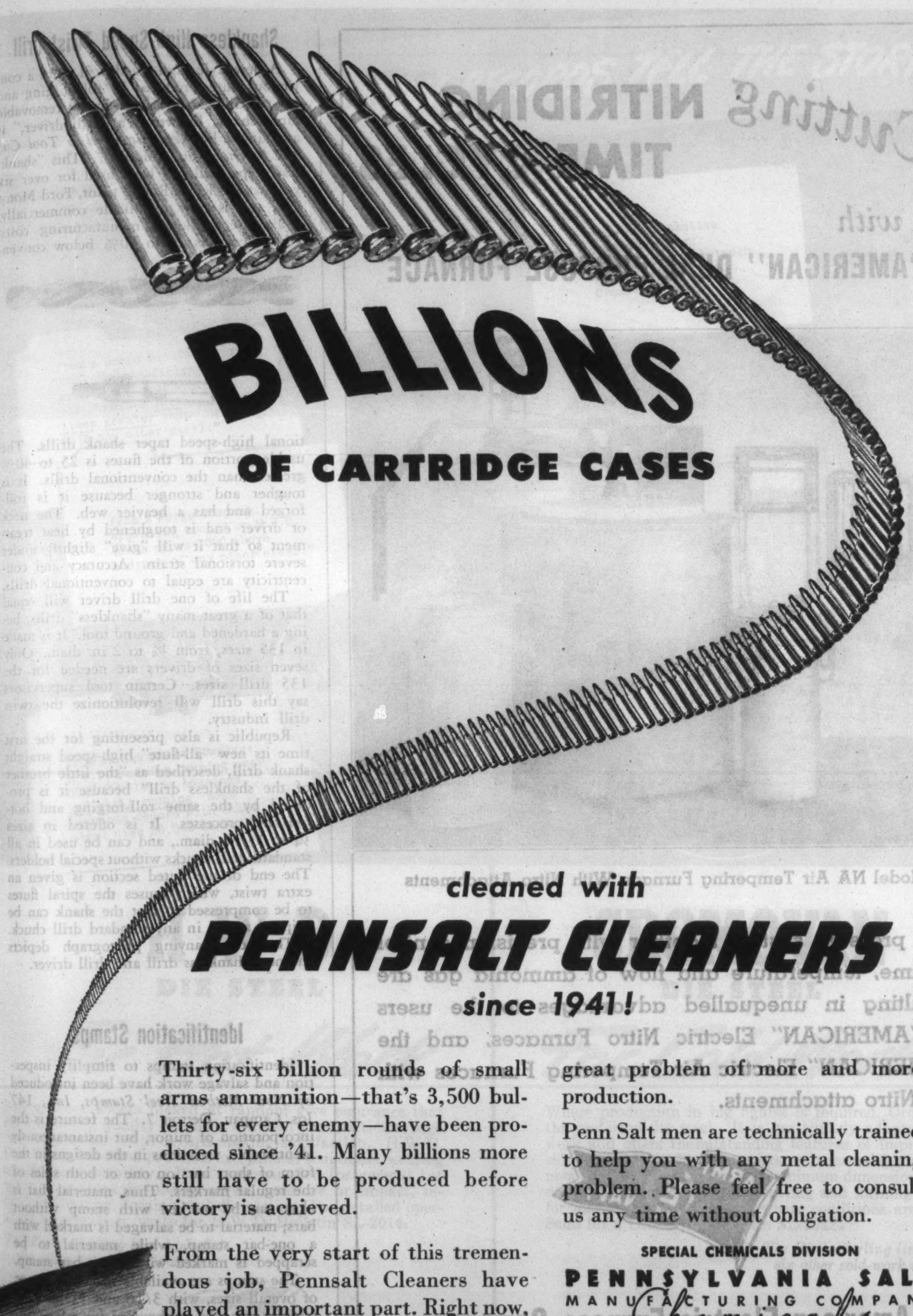
In the accompanying photograph is an ammunition case (used for illustration only), requiring the finest deep drawing steel, formed in three operations without intermediate annealing from the new steel. The size is 12 by 12 by 13 in.

Machine for Squaring, Burring, Flaring Tubes

A new, completely automatic machine for squaring, burring, flaring and beading ferrous and non-ferrous tubing, sizes 1/8 in. to 3' in. O.D., is now available from *Leonard Precision Products Co.,* Garden Grove, Calif. Due to the development of larger aircraft, Model 3CP, the newest of the line of Leonard "Tube Masters," was developed and perfected as a completely automatic machine.

The Model 3CP greatly exceeds the production performance of the 1942 tube master, the model that eliminated hand tools and dies in squaring, flaring, burring and beading non-ferrous tubing operations.

Model 3CP has greater capacity, is completely automatic, and will handle ferrous as well as non-ferrous tubing in all four operations. The operator places the tube in position and presses the control button. The machine automatically completes the cycle of squaring and burring, flaring or beading ferrous or non-ferrous tubing. Uniformity of finish can be maintained indefinitely to exact predetermined specifications.



BILLIONS

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Thirty-six billion rounds of small arms ammunition—that's 3,500 bullets for every enemy—have been produced since '41. Many billions more still have to be produced before victory is achieved.

From the very start of this tremendous job, Pennsalt Cleaners have played an important part. Right now, Pennsalt Cleaners are offering valuable aid to cartridge case manufacturers who are still faced with the great problem of more and more production.

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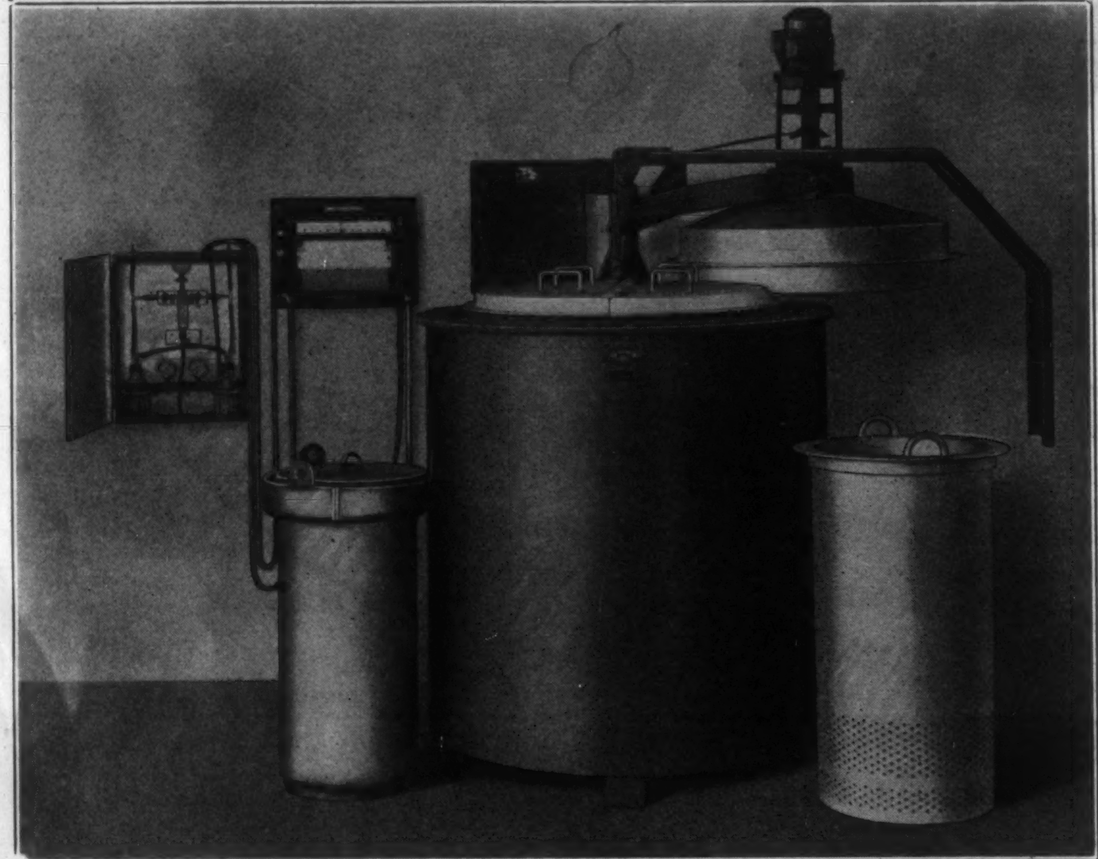


Model NA Air Tempering Furnace With Nitro Attachments

The pressure system together with precision control of time, temperature and flow of ammonia gas are resulting in unequalled advantages to the users of "AMERICAN" Electric Nitro Furnaces, and the "AMERICAN" Electric Air Tempering Furnaces with the Nitro attachments.

ARMY E NAVY

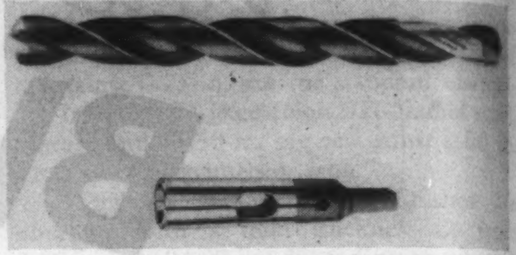
American Electric Furnace Company
29 Von Hillern St., Boston, Mass., U.S.A.

Industrial Furnaces for All Purposes

Shankless High-Speed Twist Drill

A new style high-speed drill, with a continuous flute, produced by roll-forging and hot-twisting and driven by a removable taper shank, known as a "drill driver," is announced by *Republic Drill & Tool Co.*, 322 S. Green St., Chicago 7. This "shankless" type drill has been used for over six years at the River Rouge plant, Ford Motor Co., and is now obtainable commercially.

Because of lower manufacturing costs, selling price is 20 to 30% below conventional high-speed taper shank drills. The usable portion of the flutes is 25 to 40% greater than the conventional drills. It is tougher and stronger because it is roll-forged and has a heavier web. The neck or driver end is toughened by heat treatment so that it will "give" slightly under severe torsional strain. Accuracy and concentricity are equal to conventional drills.



The life of one drill driver will equal that of a great many "shankless" drills, being a hardened and ground tool. It is made in 135 sizes, from ¼ to 2 in. diam. Only seven sizes of drivers are needed for the 135 drill sizes. Certain tool supervisors say this drill will revolutionize the twist drill industry.

Republic is also presenting for the first time its new "all-flute" high-speed straight shank drill, described as "the little brother of the shankless drill" because it is produced by the same roll-forging and hot-twisting processes. It is offered in sizes ¼ to ½ in. diam., and can be used in all standard drill chucks without special holders. The end of the fluted section is given an extra twist, which causes the spiral flutes to be compressed so that the shank can be gripped firmly in any standard drill chuck.

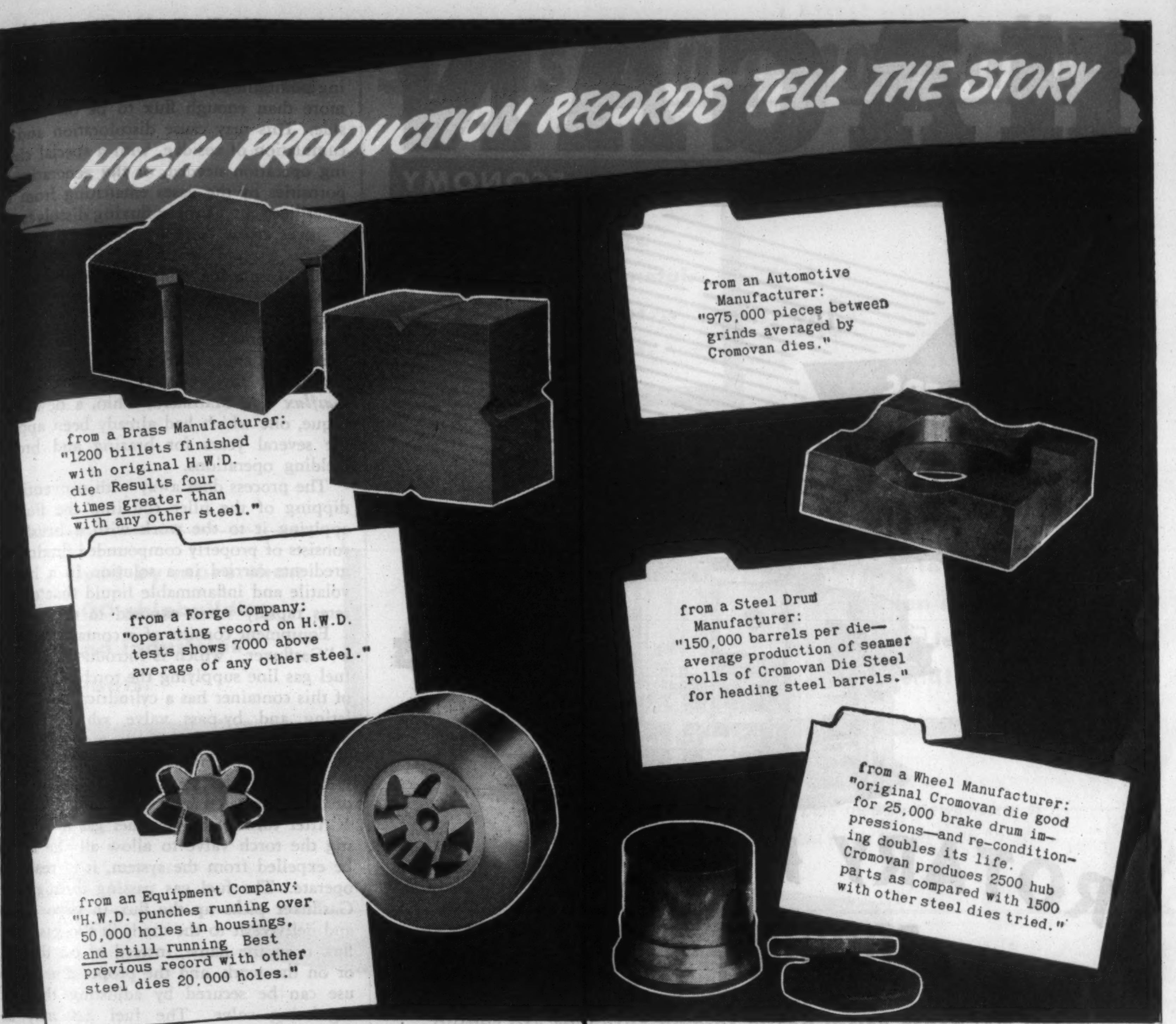
The accompanying photograph depicts the new shankless drill and drill driver.

Identification Stamps

Identification stamps to simplify inspection and salvage work have been introduced by *New Method Steel Stamps, Inc.*, 147 Jos. Campau, Detroit 7. The feature is the incorporation of minor, but instantaneously identificable, variations in the designs in the form of short bars on one or both sides of the regular markers. Thus, material that is okay can be marked with stamp without bars; material to be salvaged is marked with a one-bar stamp, while material to be scrapped is marked with a two-bar stamp.

The stamps are available in a wide range of overall sizes, with 3/16 and ¼ in. most popular. Shanks are knurled for safer gripping. They have an extra strong heavy bevel, insuring deep, clean-cut impressions. Each stamp is heat treated, the upper portion of the shank showing the correct temper color, indicating that it has the degree of hardness best suited to prevent chipping and mushrooming under impact.

HIGH PRODUCTION RECORDS TELL THE STORY



from a Brass Manufacturer:
"1200 billets finished with original H.W.D. die Results four times greater than with any other steel."

from a Forge Company:
"operating record on H.W.D. tests shows 7000 above average of any other steel."

from an Equipment Company:
"H.W.D. punches running over 50,000 holes in housings, and still running Best previous record with other steel dies 20,000 holes."

from an Automotive Manufacturer:
"975,000 pieces between grinds averaged by Cromovan dies."

from a Steel Drum Manufacturer:
"150,000 barrels per die—average production of seamer rolls of Cromovan Die Steel for heading steel barrels."

from a Wheel Manufacturer:
"original Cromovan die good for 25,000 brake drum impressions—and re-conditioning doubles its life. Cromovan produces 2500 hub parts as compared with 1500 with other steel dies tried."

H W D

DIE STEEL

For Hot Work

Performance sheets picked at random give assurance that Firth-Sterling quality die steels will meet your particular high output problem with record-making satisfaction. H.W.D. Hot Work Die Steel provides exceptional toughness, wearing quality and stability. It is recommended for general hot work operations involving severe pressure or impact, including forming, forging and die casting. For detailed operating information, write for H.W.D. Bulletin SL-2014.

The Firth-Sterling line includes six other hot-work die steels

CROMOVAN

DIE STEEL

For Cold Work

Where production in big figures is required, Cromovan is the preferred die steel. It is particularly adapted to cold work and offers the outstanding features of improved machinability, high abrasion resistance, unusual depth of hardness (preventing sinking), and minimum dimensional change during hardening. Used for cutting and forming dies, and for many special operations where conditions are unusual. Send for a Cromovan Bulletin SL-2022.

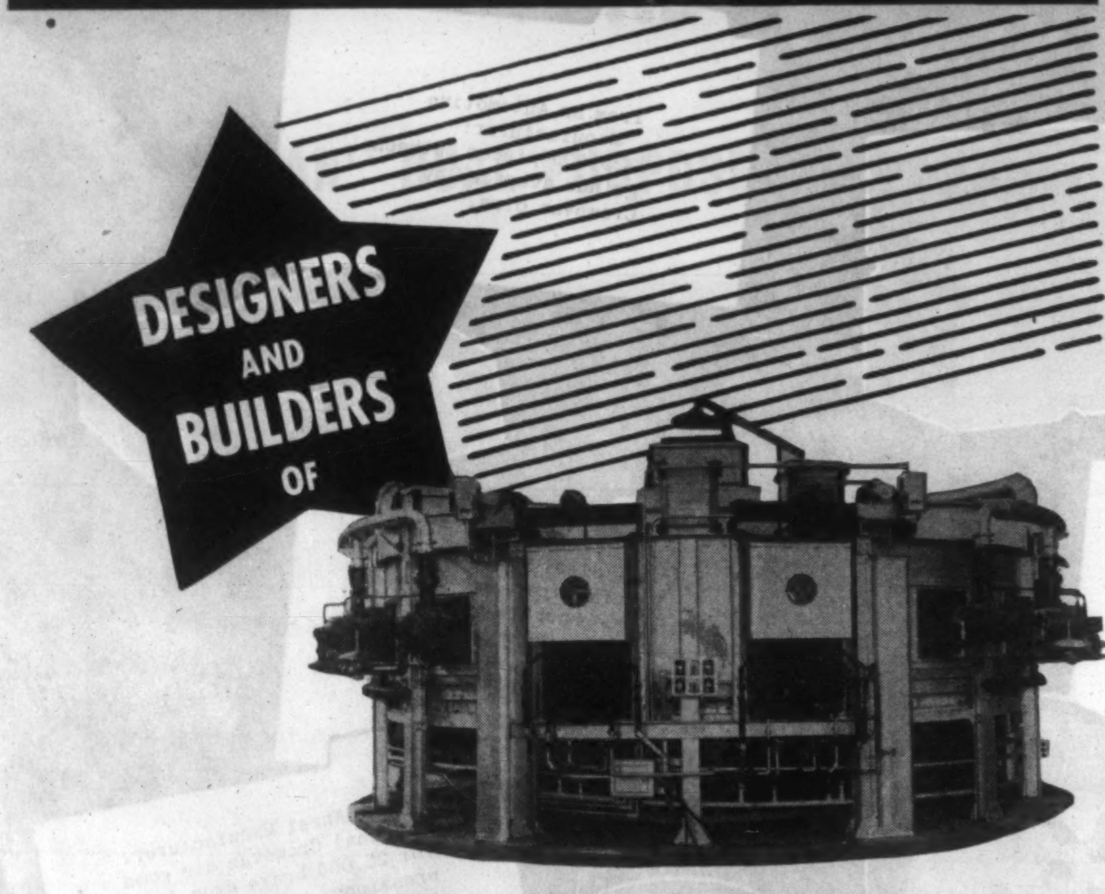
The Firth-Sterling line includes six other cold-work die steels

Firth-Sterling
STEEL COMPANY

OFFICES: McKEESPORT, PA. · NEW YORK · HARTFORD · PHILADELPHIA · PITTSBURGH · CLEVELAND · DAYTON · DETROIT · CHICAGO · LOS ANGELES

HAGAN

PERFORMANCE · UNIFORMITY · ECONOMY



ROTARY HEARTH
FORGING FURNACES

Nearly 200 Hagan Rotary Hearth Forging Furnaces are setting new production and cost records for many of America's leading manufacturers. Accurate control of heating time and temperature insure a continuous flow of uniformly heated billets varying from 1"x 1" to 10"x 10" sections. Less heating time is required, fuel consumption is reduced in some instances as much as 58%, labor costs are lower, lost furnace time is negligible. These units are available in nine sizes from 4' to 26' hearth diameters with heating capacities from 600 to 20,000 lbs. per hour.

Descriptive Bulletin will be sent on request.

GEORGE J. HAGAN CO.
PITTSBURGH, PA.
Detroit Los Angeles Chicago San Francisco

HAGAN

FURNACES
FOR EVERY INDUSTRIAL NEED

Automatic Fluxer for Silver Solder

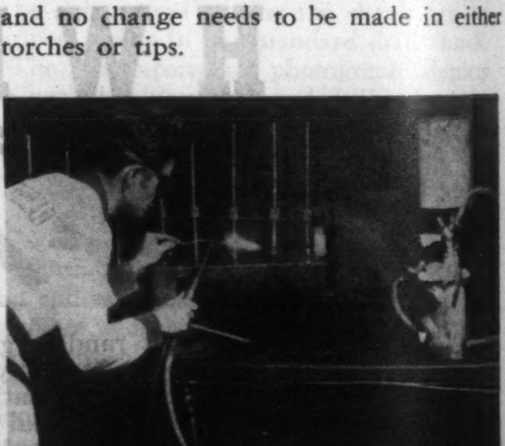
In using silver solder and other low melting point alloys, there is the tendency to use more than enough flux to be on the safe side. This may cause discoloration and accumulation of residue, with a special cleaning operation needed, or the generation of porosities by the gases emanating from the volatilized flux. Proper fluxing dissolves and removes oxides and other impurities, and induces a rapid flow of solder through the joint. Insufficient flux results in a substandard joint, hence the tendency towards over-fluxing.

An automatic supply of flux to provide the correct amount at a uniform rate is the feature of the "Gasflux" process by the *Gasflux Co.,* Mansfield, Ohio, a new technique, one which had already been applied for several years for brazing and bronze welding operations.

The process does away with conventional dipping of the filler rod into the flux or applying it to the work with a brush. It consists of properly compounded fluxing ingredients carried in a solution in a highly volatile and inflammable liquid that evaporates rapidly when exposed to the air.

Equipment consists of a container, called a "Gasfluxer," which is introduced into the fuel gas line supplying the torch. The head of this container has a cylindrical flux regulating and by-pass valve which permits operation with any desired amount of flux, or with no flux if used as a complete bypass. The interior contains a cotton wick or filter, saturated with the liquid.

After turning on the fuel gas and opening the torch valve to allow all the air to be expelled from the system, it is ready to operate. The fuel gas passing through the Gasfluxer picks up the flux in vapor form and delivers it to the torch in the gas. The flux is in the flame, instead of on the rod or on the work, and the proper amount to use can be secured by adjusting the flux regulating valve. The fuel gas may be acetylene, city gas, or any other gas that is suitable for the conditions of the work; and no change needs to be made in either torches or tips.



A reserve tank of one gal. capacity is attached to the Gasfluxer for convenience in refilling without stopping operations, and a sight glass on the bottom part of the container body provides for observation of the liquid level.

Presence of the vaporized flux in the fuel gas stream imparts a brilliant green color to the flame, which tends to mask the inner

(Continued on page 256)

End-weld Studs Automatically!

Nelson studs are end-welded to metal. No drilling holes... no welding bolts.

Used by more than 500 shipbuilding and industrial plants.

Complete fusion between stud and plate in less than ½ second!

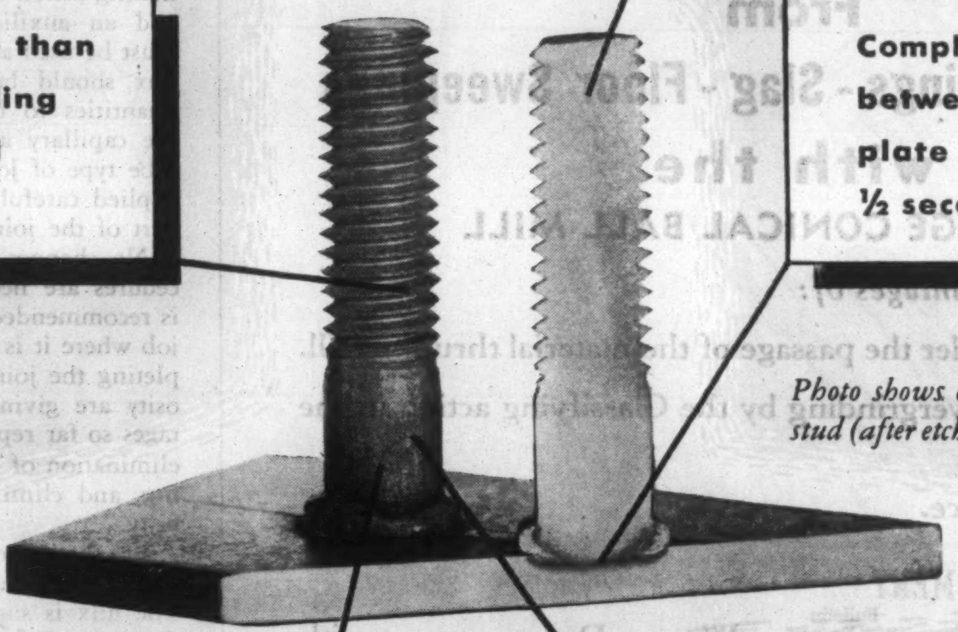


Photo shows cutaway view of stud (after etching with Nital).

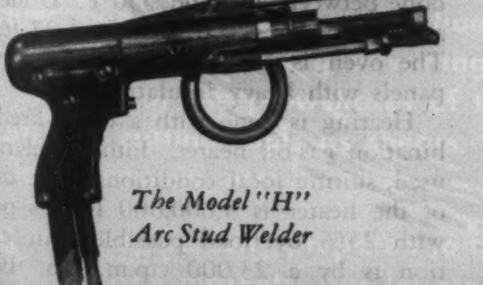
Operators can weld 500 to 1000 studs a shift. Completely automatic operation.

Many diameters, lengths, and types, for securing parts of all kinds.

For complete details and catalog, write:

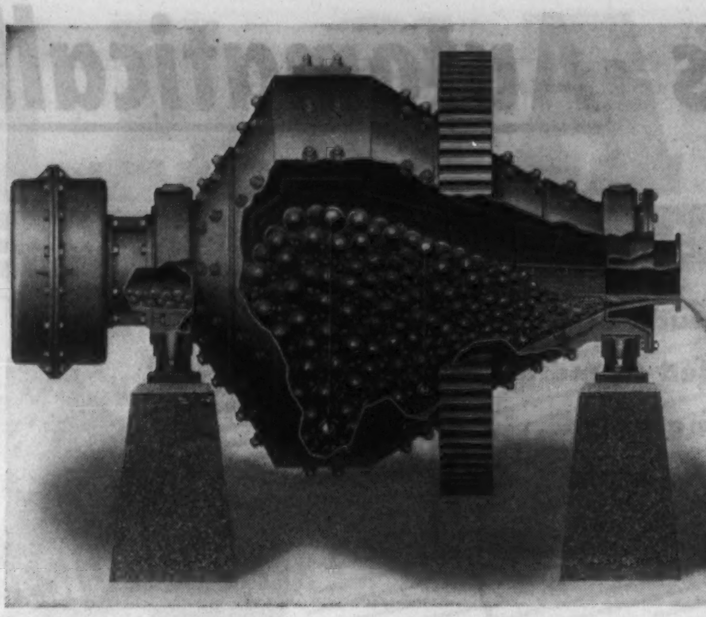
NELSON SPECIALTY
WELDING EQUIPMENT CORPORATION
Dept. MA, 440 Peralta Ave., San Leandro, Calif.

Eastern Representative: Camden Stud Welding Corp.
Dept. 122, 1416 So. Sixth St., Camden, N. J.



The Model "H" Arc Stud Welder

NELSON STUD WELDERS & STUDS



Reclaim Metal
From
Dross - Skimmings - Slag - Floor Sweepings
with the
HARDINGE CONICAL BALL MILL

This mill has the advantages of:

(1) No grate to hinder the passage of the material thru the mill.

(2) Prevention of overgrinding by the Classifying action in the Conical Mill.

(3) Low Maintenance.

HARDINGE EQUIPMENT

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Mills, Tube	18-A
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"Thermomill"	17-B
Thickeners	31-C

Wet or Dry treatment with or without Classifiers - Pumps - Thickeners - Tables - Screens.

Submit your problem and we will recommend the correct flowsheet.

Bulletin 8-A

HARDINGE
COMPANY, INCORPORATED — YORK, PENNSYLVANIA
NEW YORK, CHICAGO, SAN FRANCISCO, TORONTO

CONICAL MILLS | COUNTER CURRENT CLASSIFIERS | THICKENERS CLARIFIERS | RUGGLES-COLES DRYERS | CONSTANT WEIGHT FEEDERS | TUBE ROD AND BATCH MILLS

MR-9

cone. However, the flame structure can readily be seen with welding goggles, and, therefore, all adjustments of the torch are made while wearing welding goggles, which preferably are fitted with green lenses. Final adjustment of the torch should be made to give a mild brush-like flame, because a mild flame does not blow the filler metal away and gives a very smooth finished joint.

An important difference between using the Gasflux process for silver solder and for brazing with the various copper-base alloy rods is that with silver solders much less flux is used. There is no danger of missing any part of a joint because the flux is being supplied continuously through the flame.

Lap and press fit joints (such as the tube within a tube type) necessitates a special technique because these joints usually present very little clearance between the members and it is important to get effective capillary action for a firm bond. Since the flame cannot positively penetrate the small clearance, it is not possible to get proper fluxing action by the use of the flame alone, and an auxiliary paste silver solder flux must be used as well. In this case, the paste flux should be applied in only sufficient quantities to cover the surfaces requiring the capillary action. In the tube-within-a-tube type of joint, the paste flux should be applied carefully and lightly to the female part of the joint.

No changes in fixtures or assembly procedures are necessary. The new procedure is recommended for use on any silver solder job where it is necessary to clean after completing the joint or where pinholes or porosity are giving trouble. Principal advantages so far reported are: Faster production, elimination of discoloration and after-cleaning, and elimination of pinholes and porosity.

In the accompanying photograph the Gasfluxer appears on the bench at the right. The flux is supplied automatically through the flame.

Foundry Core Oven

An interesting horizontal-type foundry oven is announced by the *Despatch Oven Co.,* Minneapolis 14. It has four levels of horizontal core travel. Cores are loaded in the open section and travel vertically to the baking oven at the top, where they make two horizontal passes in the heating system. As they enter the third horizontal level they pass through a cooling zone and enter the unloading station cool enough to handle.

A typical oven has capacity for 50,000 lb. of cores every 8 hr. Maximum temperature provided is 650 F. though most baking is done between 450 and 550 F. Dimensions are 52 ft. long, 13 ft. wide and 27 ft. high. The oven is built of double steel walled panels with heavy insulation.

Heating is done with a direct-fired combination gas-oil heater. Either fuel may be used, suiting local conditions. The capacity of the heater is 3,000,000 B.t.u.'s per hr., with 25% overload possible. Air circulation is by a 23,000 c.p.m. fan. Besides, there are two exhaust fans.

The system has 36 carriers, each having four adjustable shelves. Conveyor speed is adjustable. Automatic temperature control is provided throughout.

THERMONIC

The Most Efficient and Economical System for Induction Heating

Today *Swords*...Tomorrow *Plowshares*

Many of war's implements owe their superior properties to the technical advances made by Induction Heating in improving and speeding up the brazing, annealing, hardening, melting and forging of ferrous and non-ferrous metals.

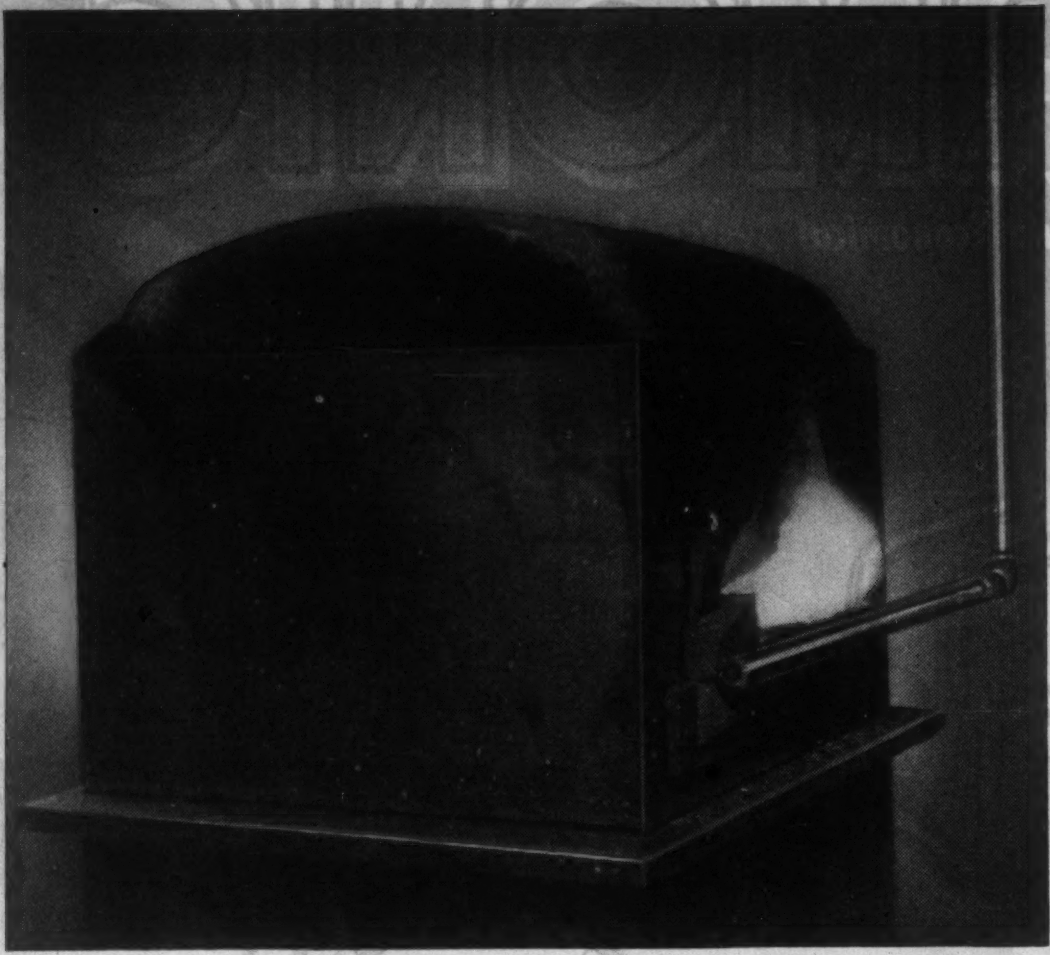
One of the most important applications of Induction Heating is the selective surface hardening of steel sections. This method produces parts that are uniform in structure and hardness without causing decarburization or affecting the portion so treated; as for example the mine sweeper cable cutter, illustrated above.

Thermonic generators and production systems, by the addition of time-saving and cost-saving advantages promise significant product improvements for the *plowshares* of tomorrow; for the innumerable types of such cutting tools as shears, knives, saws, chisels, cleavers, pliers, lawn mowers, etc.

So that you may be fully prepared to meet the needs of your industry in the post-war's markets, our laboratory and engineering facilities invite the opportunity to work with you—on both problems and plans.

INDUCTION HEATING CORPORATION • 389 LAFAYETTE STREET, NEW YORK 3, N. Y.

Largest Producers of Electronic Heat Treating Equipment for brazing · melting · hardening · forging · annealing



Oil-fired forge constructed of J-M Firecrete.

Millers Falls Co.

PROLONGS FORGE LIFE

with J-M FIRECRETE

YEARS AGO the Millers Falls Co. had serious trouble with the refractory linings in their forge furnaces. These forges, used in the production of their fine hand tools, were of fire brick construction and lasted on an average only 6 months.

After study and experiment, the forges were cast with Johns-Manville H. T. Firecrete—the castable refractory. Firecrete did the job. Despite the high temperatures, the original Firecrete forges are still operating—more than six years after the first were cast. Thus, in production time saved, the use of J-M Firecrete has paid for itself over and over again.

Firecrete is a selected, gradated, calcined refractory which is mixed with water on the job and handled like concrete mix. It can be placed in service within 24 hours of pouring or tamping. Three grades of Firecrete are available—Standard Firecrete, 2400° F.; H. T. Firecrete, 2800° F.; and L.W. Firecrete, 2200° F. For complete details, write for booklet RC-13-A, Johns-Manville, 22 E. 40th Street, New York 16, N. Y.

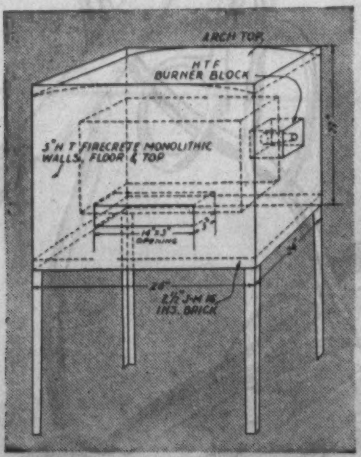


Diagram of a typical forge at the Millers Falls Co. in their plant at Millers Falls, Mass.

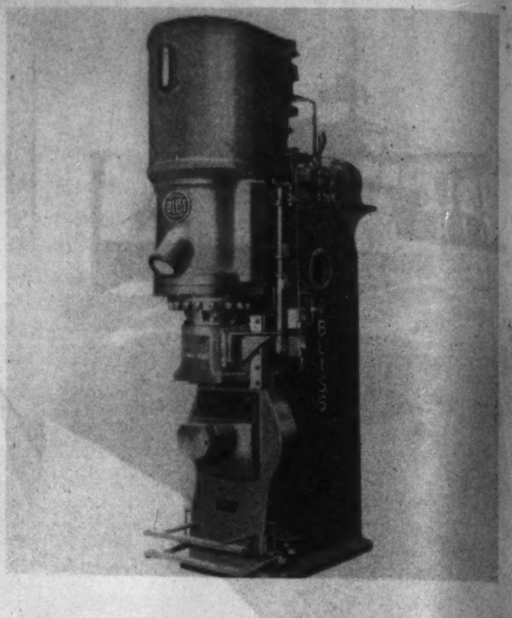
JOHNS-MANVILLE Firecrete

The Standard in Castables

Hydraulic Horn Press

A new horn-type hydraulic press for manufacturing automobile rims encloses practically all working parts and is another indication of the trend towards compact and rugged presses eliminating all protuberances. It was built by *E. W. Bliss Co.*, 53rd St. & Second Ave., Brooklyn 32. It embodies the Bliss hydrodynamic press principles.

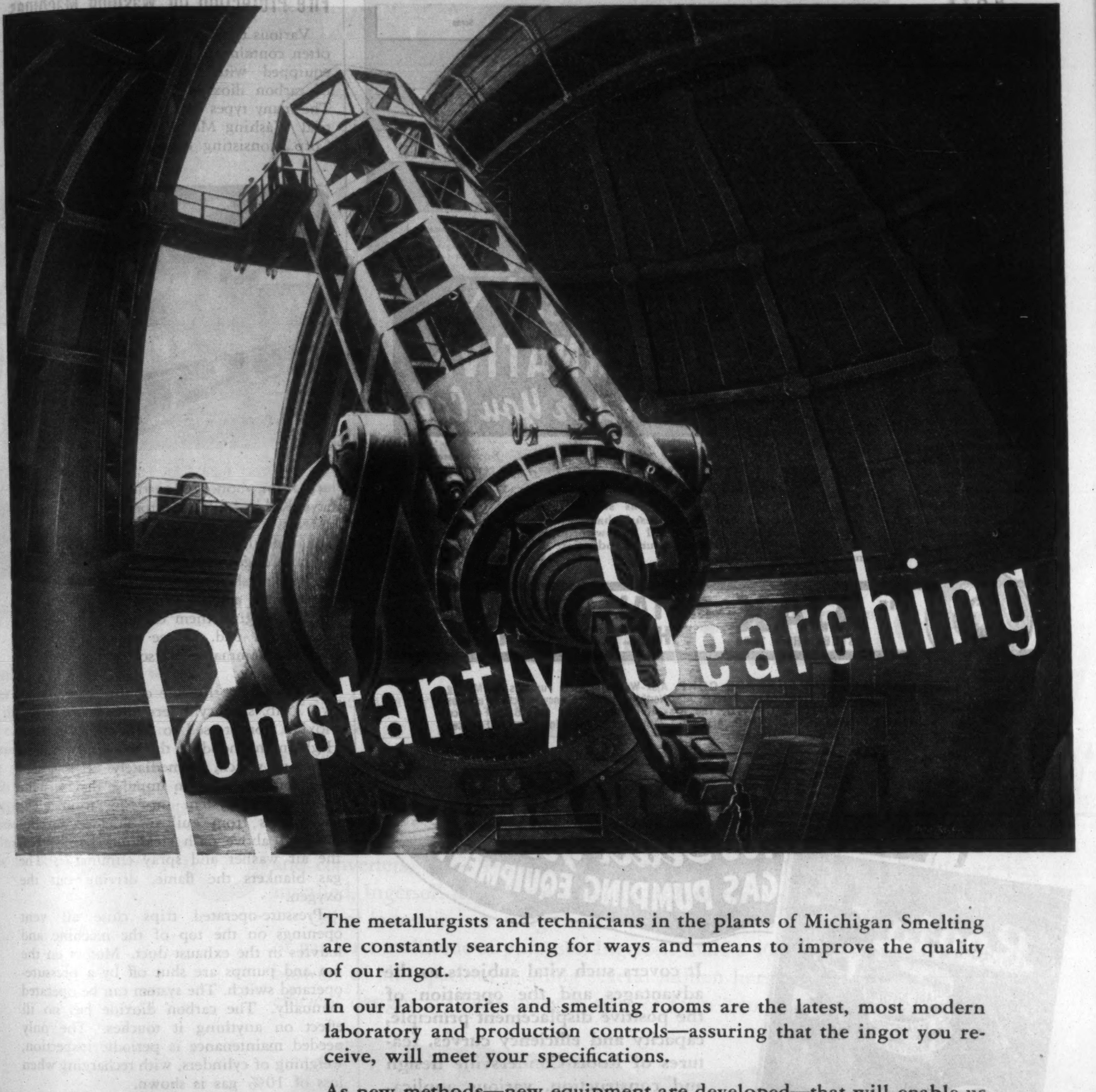
The press frame is an extremely heavy and rigid steel casting in which the horn and 300-ton hydraulic cylinder are mounted. The slide is well guided on the frame and can be provided with a shouldered slide cap if necessary. Needed for coining, a small 20-h.p. pump was installed, but larger ones are feasible for faster speed.



The small pump is satisfactory, since its normally open prefill valve and positive drive to the work permits quick build-up of pressure. Cavitation is reduced to an absolute minimum, and the press itself is self-purging of air.

Electric control by both hand and foot button is provided with either automatic reverse or reverse by the release of the foot treadle. The non-repeat device is incorporated in the automatic reverse. This 300-ton press is one of a line of gap-type presses ranging from 50- to 500-ton capacity. It is available in table type for general shop work and extended table type for straightening work. Hydraulic cushions in the bed are available.

● The standing committee in charge of reviewing Simplified Practice Recommendations R118, abrasive grain sizes, has approved a revision of this recommendation and copies have been mailed to all interested for consideration and acceptance. This recommendation covers a simplified schedule of grain sizes for aluminum oxide and silicon carbide abrasives for polishing uses and for grinding wheel manufacture. The proposed revision recommends an increase in allowable oversize in No. 46 grit from 20 to 30% and the inclusion of No. 240 grit. Mimeographed copies of the proposed revision may be obtained, upon request, from the *Division of Simplified Practice, National Bureau of Standards,* Washington 25, D. C.



The metallurgists and technicians in the plants of Michigan Smelting are constantly searching for ways and means to improve the quality of our ingot.

In our laboratories and smelting rooms are the latest, most modern laboratory and production controls—assuring that the ingot you receive, will meet your specifications.

As new methods—new equipment are developed—that will enable us to do even better than our present best—you will find their adoption in Michigan Smelting plants.

MICHIGAN SMELTING & REFINING

Division of BOHN ALUMINUM & BRASS CORPORATION, DETROIT 26, MICH.

General Offices—Lafayette Bldg.

BUY WAR BONDS

REFINERS OF NON-FERROUS SCRAP METALS FOR OVER FIFTY YEARS

NOTE

• "Proper Melting Decreases Foundry Losses," contains interesting data. Also, the booklet, "Nonferrous Ingot Metals of Today." Write for both of these. They are free.

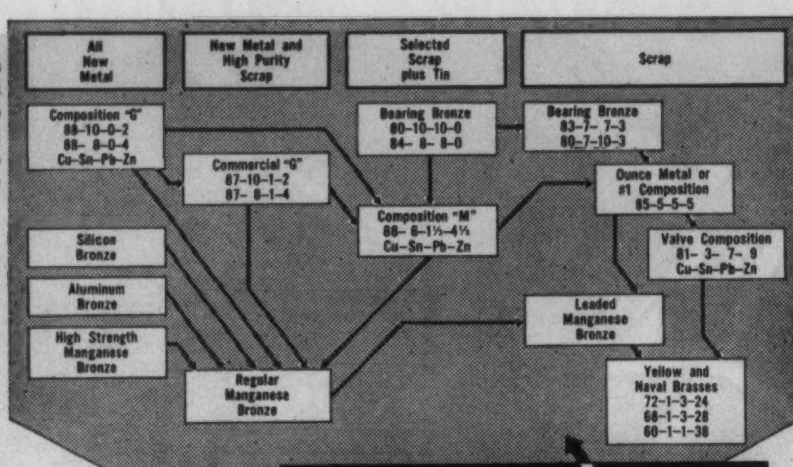
●

Send for booklet
"INGOT METALS
OF TODAY"

●

16 STANDARD INGOT METALS BY AJAX

Ajax Tombasil
Ajax Plastic Bronze
Ajax Anti-Acid Bronze
Ajax Phosphor Bronze
Ajax Red Brass Ingots
Ajax Manganese Bronze
Ajax High-Tensile Manganese Bronze
Ajax Golden Glow Yellow Brass
Ajax-Hamilton Gear Bronze
Ajax Nickel-Copper 50-50%
Ajax Manganese Copper
Ajax Aluminum Alloys
Ajax Phosphor Copper
Ajax Silicon Copper
Ajax Nickel Alloys
Ajax Phosphor Tin


All New Metal
New Metal and High Purity Scrap
Selected Scrap plus Tin
Scrap
Composition "G" 88-10-0-2 88- 8-0-4 Cu-Sn-Pb-Zn
Commercial "G" 87-10-1-2 87- 8-1-4
Bearing Bronze 80-10-10-0 84- 8- 8-0
Bearing Bronze 83-7- 7-3 80-7-10-3
Composition "M" 88- 6-1½-4½ Cu-Sn-Pb-Zn
Ounce Metal or #1 Composition 85-5-5-5
Valve Composition 81- 3- 7- 9 Cu-Sn-Pb-Zn
Silicon Bronze
Aluminum Bronze
High Strength Manganese Bronze
Regular Manganese Bronze
Leaded Manganese Bronze
Yellow and Naval Brasses 72-1-3-24 68-1-3-28 60-1-1-38

Use These
ALTERNATIVES
Wherever You Can

Notice how the arrows on the W.P.B. chart point to the *right*. . . . They show how alternative materials *currently available* can be utilized by foundrymen as now permitted by many designers. The purpose is to conserve primary metal at the mine through increased use of secondary ingots. Sometimes great ingenuity is called for, yet remember this:

The first program for scientific control of ingot metal was set up by Ajax 46 years ago. The result has been metal and practical technical follow-through in which Ajax increases your production by reducing rejects.

THE **AJAX** METAL COMPANY
ESTABLISHED 1880 PHILADELPHIA

ASSOCIATE COMPANIES:
AJAX ELECTRIC FURNACE CORP. Ajax-Wyatt Induction Furnaces for Melting
AJAX ELECTROTHERMIC CORP. Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC. The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ENGINEERING CORP. Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces

THIS BULLETIN CAN HELP YOU *Select your* GAS PUMPING EQUIPMENT

Roots
CONNERSVILLE
ROTARY POSITIVE
GAS EXHAUSTERS
AND BOOSTERS
ROOTS
Tomorrow's Engineering Tempered by Yesterday's Experience

It covers such vital subjects as the advantages and the operation of the positive displacement principle, capacity and efficiency curves, features of Roots-Connersville design and construction, various applications and drives, dimension and capacity tables on standard units for moderate pressures.

A copy of Bulletin 32-33-B-12 is yours for the asking.

ROOTS-CONNERSVILLE BLOWER CORPORATION,
One of the Dresser Industries
501 Superior Ave., Connersville, Ind.

Roots CONNERSVILLE SINCE 1854
Rotary Positive **GAS BOOSTERS**

Fire Protection for Washing Machines

Various types of metal washing machines, often containing inflammables, can now be equipped with fire-extinguishing systems of carbon dioxide built by *Walter Kidde*. The many types of washers made by Industrial Washing Machine Corp. and Dextrex Corp., consisting of conveyor, cabinet, rotary drum, monorail, vertical and teardown, have Kidde built-in automatic fire-fighting systems.

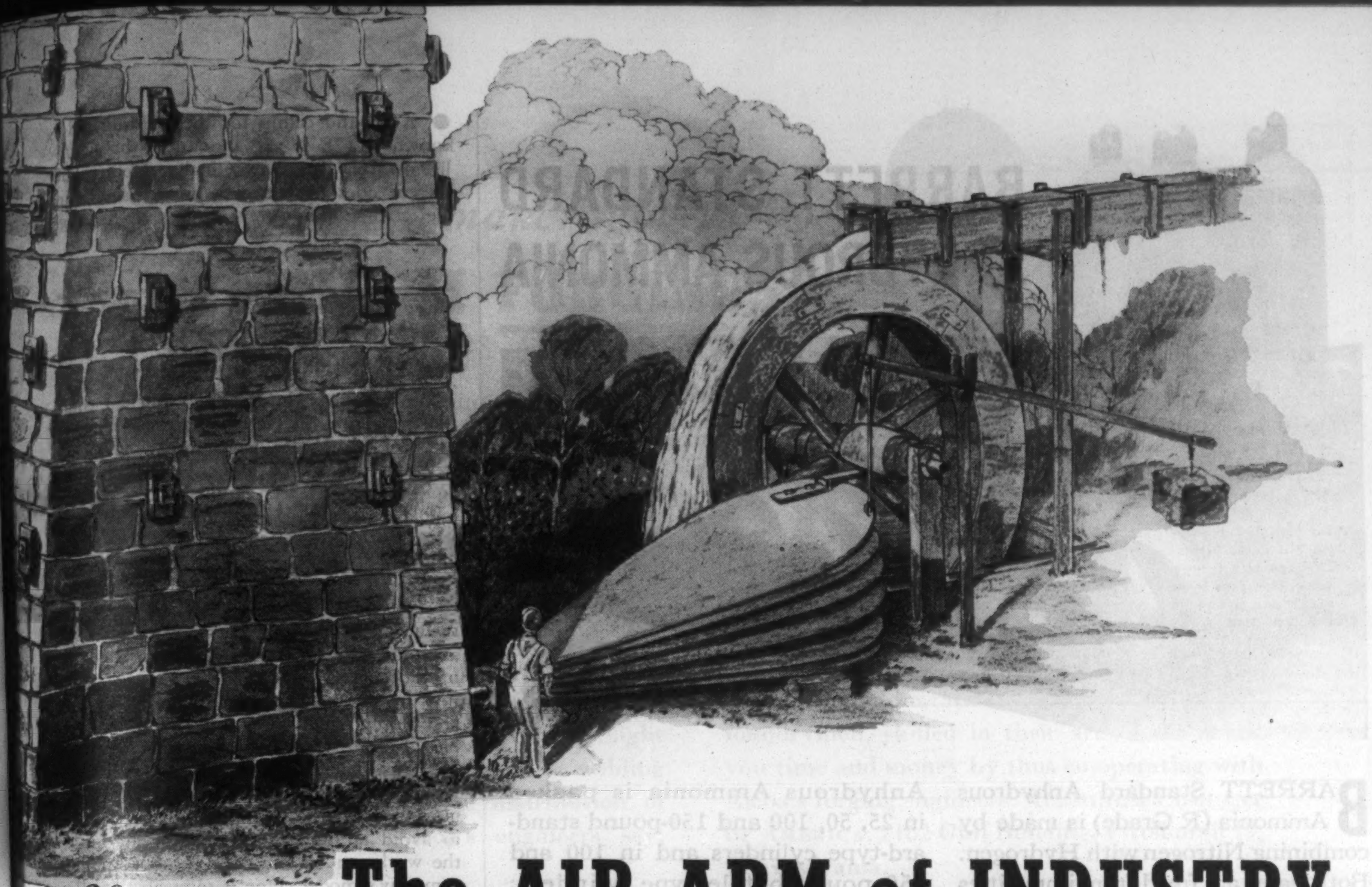
A typical washer is that used in a large airplane engine plant. It carries parts from the wire mesh conveyor through two washes and a rinse, a cold blowoff and a hot blowoff, discharging them cleaned and dried at the unload end. Three tanks supply the highly inflammable Varsol or kerosene for degreasing.

Mounted on the side of the machine are two 75-lb. steel cylinders filled with carbon dioxide, compressed to 850 p.s.i. at 70 F. High in the hood of the machine are heat actuators which, immediately at the outbreak of fire, relay an impulse that sets the fire fighting system into operation. The gas gushes from built-in shielded nozzles installed above each cleaning chamber on the air washer and spray eliminator. The gas blankets the flame, driving out the oxygen.

Pressure-operated trips close all vent openings on the top of the machine and louvres in the exhaust duct. Motors on the fan and pumps are shut off by a pressure-operated switch. The system can be operated manually. The carbon dioxide has no ill effect on anything it touches. The only needed maintenance is periodic inspection, weighing of cylinders, with recharging when loss of 10% gas is shown.

In the accompanying photograph appear conical nozzles carrying carbon dioxide into the heart of the washer.

● New spring and bellows actuated pressure gages, which measure ranges between zero and 5 in., and zero and 50 in. of water, are being made available for industry by the *Brown Instrument Co.*, Philadelphia, and the precision industrial instrument div. of *Minneapolis-Honeywell Regulator Co.* Two new types of gages are introduced. One has a single spring for pressure ranges; the other, a second spring, in tandem with the first, for vacuum and compound ranges. The new models are possible for combustion pressures and steel, petroleum, chemical and aviation engine manufacturing, processing and testing.



20 HP.

Water power converted to air ower is illustrated in this art-t's drawing based on sketches a cold blast charcoal furnace orked in the early part of the 9th century. The man standg in front of the bellows gives proper sense of the plant proortions. (From Two Centuries Iron Smelting in Pennsylnia by Richard Peters, Jr.).

The AIR ARM of INDUSTRY

Since man first blew or fanned a faltering fire, he has been experimenting with compressed air as a means of aiding combustion. The ingenious water-wheel bellows was one of his early efforts—one of many steps toward present day record-breaking production of metals.

Today it is the Turbo Blower that furnishes the air blast. These compact, centrifugal machines compress huge volumes of combustion air for the nation's furnaces and converters. Since 1913, when the first I-R Blast Furnace Turbo Blower was installed, Ingersoll-Rand has maintained its leadership in this field.

Other industries are using thousands of I-R Turbo Blowers for compressing air or gas for a multitude of purposes. Ingersoll-Rand's 30 years' experience in building blowers of all capacities totalling several million horsepower is back of the highly efficient designs available today in sizes of from 2 to 15,000 horsepower.

A MODERN
14,500 HP.
ST FURNACE
BLOWER

Ingersoll-Rand

11 Broadway New York 4, N. Y.

12-445

CENTRIFUGAL PUMPS CONDENSERS COMPRESSORS TURBO BLOWERS ROCK DRILLS AIR TOOLS OIL AND GAS ENGINES

BARRETT STANDARD ANHYDROUS AMMONIA

BARRETT Standard Anhydrous Ammonia (R Grade) is made by combining Nitrogen with Hydrogen. Both gases are freed from impurities before combining; consequently, the highest purity possible is obtained. Before shipment it passes rigid tests for moisture, non-condensable gases and other impurities. Barrett's standard of purity and service make Barrett Standard Anhydrous Ammonia your best source of NH_3. Barrett Standard Anhydrous Ammonia is packed in 25, 50, 100 and 150-pound standard-type cylinders and in 100 and 150-pound bottle-type cylinders; and in tank cars with a capacity of 26 tons NH_3. Stocks of cylinders are maintained at various warehouses throughout the United States and immediate shipment can be made.

The advice and help of Barrett technical service men are available to you for the asking.

Barrett

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET, NEW YORK 6, N. Y.

Free: An interesting and helpful booklet, packed with useful information about Anhydrous Ammonia, will be mailed to you free on request.

BARRETT Standard ANHYDROUS AMMONIA

● A ground clamp for the welding field, known as "E-Z," is announced by *Will-Weld Mfg. Co., Inc.*, Omaha, Nebr. The current does not travel a great distance in the clamp, thus preventing over-heating.

Plants and Slants

Because they know how much fathers like to play with electric trains, a number of steel companies have turned to using working models of cranes and steel mill equipment to teach employees the fundamentals of safety, the *American Iron & Steel Institute* reports. Women, too, enjoy "playing" with the models as they learn. One steel company has a model crane, equipped with every type of safety feature, including fire extinguishers, warning signs and safety guards. It is constructed of movable parts and has a real magnet, picking up weights of approximately 500 lb., and doing anything a big crane will. It has a limit stop, with regulation controls. It trains classes so that new operators can learn how to handle loads with the fewest movements. The operator will learn how to avoid taking chances that might injure the workmen on the floor below. Another company's model crane is somewhat smaller and is mounted on a structure 4 ft. high, with the hoist traveling horizontally 4 ft. On casters, it can be moved easily from one department to another. One safety instructor has worked out a skit and a model stage set which provide laughs and a pointed safety lesson.

There is something unique about the awards of Army-Navy "E" and subsequent stars to *Matam Corp.*, 45-17 Pearson St., Long Island City, N. Y., maker of airplane motors, shells, etc. Originally, the plant of the Mathis Motor Works, as it was known in Europe, was in Strasbourg. The president, E. C. Mathis, ordered the plant dismantled to prevent its use by Hitler. The organization moved to the United States and its success is attested by its "E" and stars.

Seven Russian engineering specialists were visiting American industrial plants in November, including combustion control of boilers at the plant of *Hagan Corp.*, Pittsburgh. Outstanding interest of the Russians was the extent to which American industry specializes. They were impressed most by the large number of sub-contracting firms required to produce component parts for a maker of a finished machine, an ideal to which Russia aspires.

The *Sonntag Scientific Corp.*, testing engineers, has completed a new testing laboratory at 1 Seneca Place, Greenwich, Conn. It contains the most up-to-date dynamic testing equipment, such as large rotating beam fatigue testers, constant load universal fatigue testers of various capacities for tests in tension, compression, bending, torsion of specimens and supplementary equipment for static tests. The company deals exclusively in fatigue and vibration research.

The Soviet Government will pay \$20,-

What's a pattern maker got to do with ALUMINUM FORGINGS?

You've decided on an aluminum forging because of its high strength-weight ratio. But stresses will be complex. You can't be sure of the design until the part is completed, and dies cost a lot of money to make and change. So here's where the multiple interests of Alcoa can serve you:

Patterns are made according to your design. Cast in sand, the piece is then tested in Alcoa's stress analysis laboratory. Patterns are changed to suit, new castings made and tested. Slight changes are made by machining off or welding on metal. When the desired distribution of stresses is obtained, Alcoa's engineers say, "There's your design".

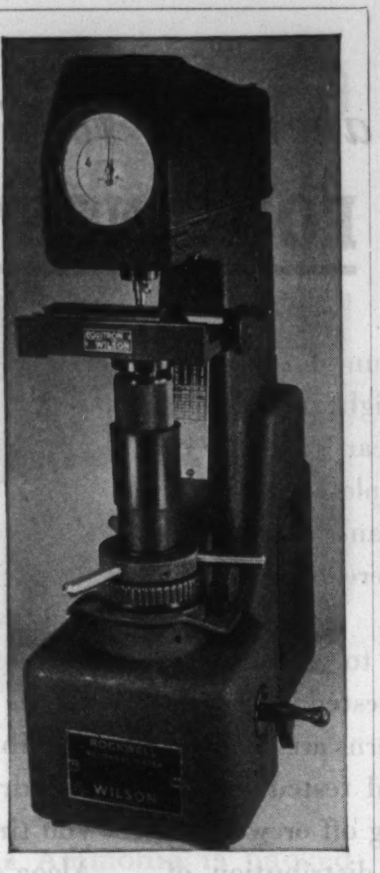
Now we make the forging dies. Because the forging has the same shape and a similar elastic modulus as the casting, stresses will be distributed alike. Alcoa pattern makers and foundrymen, skilled in their arts, have saved you time and money by thus co-operating with Alcoa's forging engineers. ALUMINUM COMPANY OF AMERICA, 2162 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN ALUMINUM

"ROCKWELL"
HARDNESS TESTER

When you equip your metallurgical laboratory with one of our Testers, you may use the machine for research work, for the establishment of specifications, for inspection testing of samples from your Production Department and, by adding the inexpensive "Equitron," you may use the same tester for the hardness tests required in making the Jominy End-Quench Test.

If, however, you have a research problem that requires the study of hardness conditions on the very surface, as for example the hardness of chrome plate of half a thousandth or more, you need our "TUKON" TESTER with "KNOOP" Indenter. Bulletin TK-45 describing the "TUKON" TESTER will be sent on request.

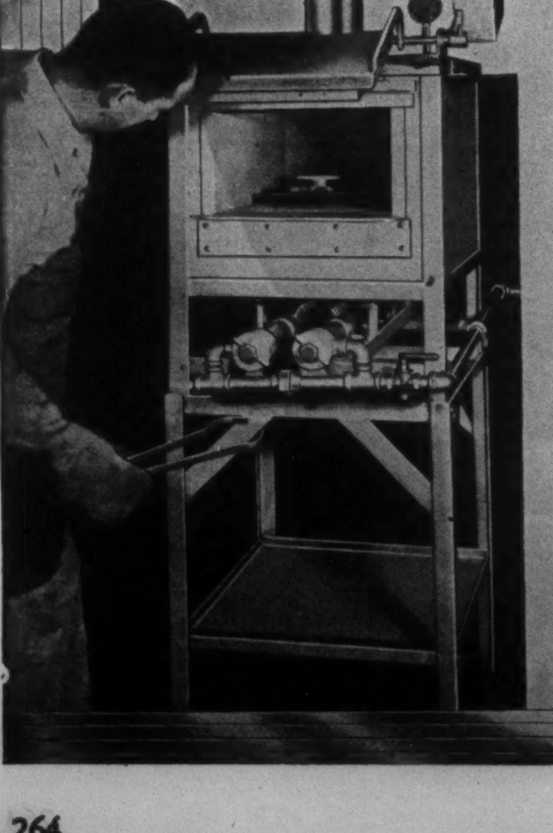


The "EQUITRON" shown as an attachment to the "ROCKWELL" Tester was fully described in last month's advertisement.

ACCO
AN ASSOCIATE COMPANY OF
AMERICAN CHAIN & CABLE COMPANY. INC

WILSON
MECHANICAL INSTRUMENT CO. INC.
365 Concord Ave. New York 54, N. Y.

Baker Gas Furnaces
TEMPERATURES UP TO 2400° F.
WITHOUT A BLOWER



BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6" x 8" x 5½", to No. 24, which is 12" x 20" x 8" as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6" x 12" x 5", is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½" x 15" x 2½" high.

Special size furnaces built to your order. Write for descriptive folder and prices.

BAKER & CO., INC.
113 Astor St., Newark, N. J.

000,000 in U. S. currency to the Canadian Government as full and final compensation for taking over the Petsamo nickel mines in Finland, which that country had originally leased to the *International Nickel Co.* Payment will be made over six years. The mines contain over 5,000,000 tons of rich nickel-copper ore—nickel 2% and copper 1.5%.

Hercules Powder Co. has purchased a twin-engine low-winged Beechcraft monoplane for use of executives traveling among the company's own plants. Vital production items of Hercules are rocket powder, smokeless powder, TNT and ammonia.

Alloys Development Co. has licensed *Carnegie-Illinois* and other subsidiaries of *U. S. Steel, Republic Steel Corp.* and *Lukens Steel Co.* for the manufacture of "Aldecor," a steel of the "Cor-Ten" type. It has been tested for box car ends and other parts of freight cars, mine cars, etc. Metals in these alloy steels are chromium, molybdenum, copper and nickel.

Ore from historic Iron Mountain, Mo., went into commercial production of pig iron on Nov. 29 in the blast furnace plant of *Koppers Co., Inc.*, Granite City, Ill. The mine is located in Iron and St. Francois Counties, Mo., and has been rehabilitated by *Ozark Ore Co.*, subsidiary of *M. A. Hanna Co.*, in cooperation with the *Defense Plant Corp.* A feature is the nearness of the ore to the blast furnace, 80 miles.

Western Electric Co. observed its 75th anniversary in November. A feature was the showing of the film, "Heritage for Victory," which dramatizes the growth of the company. History was started by Enos Barton, of Rochester, N. Y., who with $400 began the manufacture of finer telegraph instruments.

The *Greenfield Tap & Die Corp.*, Greenfield, Mass., has bought the *Geometric Tool Co.*, New Haven, Conn. It will give Greenfield the most complete coverage of the threading tool field.

Industries Counsel Associates, Inc. has been organized at 280 Madison Ave., New York, to service industry in the field of public relations, engineering analysis of plant facilities, market research, product research and design, etc. It is headed by Rupert S. Stern.

Within 60 days after present government restrictions are lifted, *Stewart-Warner Corp.* will be producing and shipping civilian radios from what is now reputedly the largest privately-owned shell fuze plant in the United States, states Frank A. Hiter, senior vice president.

With Gary tubes as the basis, rocket production by the *National Tube Co.* is in full production. The war head is made at Christy Park from seamless pipe. At the McKeesport plant the front and back ends of the rocket body are shaped from heated pipe sections under hydraulic pressure followed by sandblasting, machining and painting.

Increases in steel wages by the War

Unexcelled Engineering Service

FOR LIQUEFIED PETROLEUM GAS UTILIZATION

NEW YORK

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As the world's largest marketer of Liquefied Petroleum Gas, Phillips Petroleum Company is justly proud of a complete and thoroughly experienced Philgas engineering staff. This competent group is qualified in every phase of LPG application.

They are ready to study your industrial heating problems NOW. A complete survey of your plant requirements will be made at no cost or obligation. Simply contact the nearest Philgas branch office.

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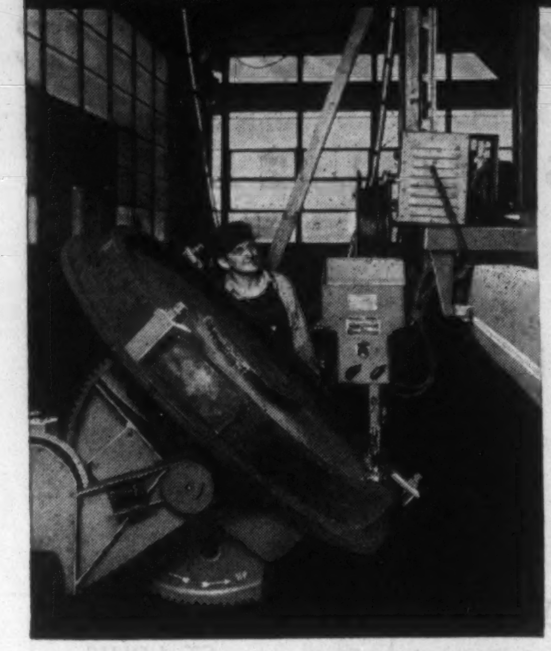
Branch Offices in NEW YORK, CHICAGO, PHILADELPHIA, DETROIT, ST. LOUIS, MILWAUKEE, SHREVEPORT, LA., AMARILLO, TEX., HIBBING, MINN.

The World's Largest Marketer of Liquefied Petroleum Gas



POSITIONER

C-F POSITIONERS

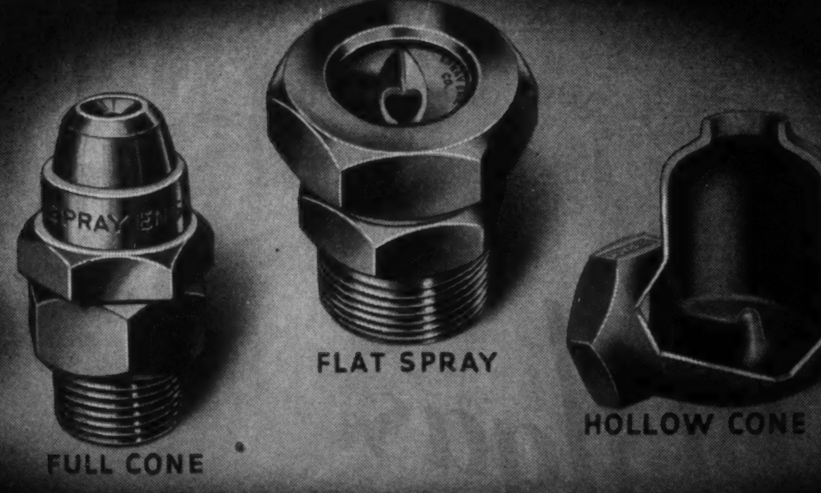
When "Position" Counts Most

On automatic welding jobs, like the one illustrated here, position counts "most," and with the C-F Positioner (with 6 sizes, and capacities to 30,000 lbs.) the tables tilt to 135° beyond horizontal and rotate 360°, all under push button control. The exclusive C-F Variable-Speed Control gives table rotations ranging from 0 R.P.M. up for all sizes. For "quick change" of position, for greater time saving and efficiency, for lower costs and greater safety to men and materials, specify C-F Positioners for all *automatic* and production welding operations.

Write for Bulletin WP-22

CULLEN-FRIESTEDT CO.

1314 S. Kilbourn Ave. Chicago 23, Ill.



SPRACO NOZZLES

Write for NOZZLE CATALOG *to*

SPRAY ENGINEERING CO.

109 CENTRAL STREET • SOMERVILLE 45, MASS.

Labor Board were not justified, states Irving S. Olds, chairman, *U. S. Steel.* While, officially, the cost of living has risen 29 to 30% since January, 1941, steel wages have already risen from 43 to 65%.

Among the first to receive the first White Star on Army-Navy "E" flags is the *National Forge & Ordnance Co.,* Irvine, Warren County, Ohio. To be eligible one must be engaged in continuous war production for at last three years and have received the "E" and four previous White Stars.

News of Engineers

Willis T. Cramer has been named assistant director of research, American Steel & Wire Co., having been works metallurgist at the company's Cuyohaga Works. He has had much experience in physical laboratories.

B. J. Fletcher was made chief engineer, New Kensington branch, Aluminum Co. of America, having been with Alcoa 18 years, mostly in development type of work. *Frank Jardine,* in charge of development work in Cleveland, is now manager, Development Div., Cleveland branch, having joined Alcoa in 1918.

Paul B. Greenawald, with Carpenter Steel Co. for 20 years, has been made general superintendent, mill operations. *George V. Luerssen,* for 37 years with the metallurgical department, has been made assistant chief metallurgist.

Carroll F. Powell has joined Battelle Institute to engage in non-ferrous metallurgy research, having formerly been with Basic Magnesium, Inc., Las Vegas, Nev.

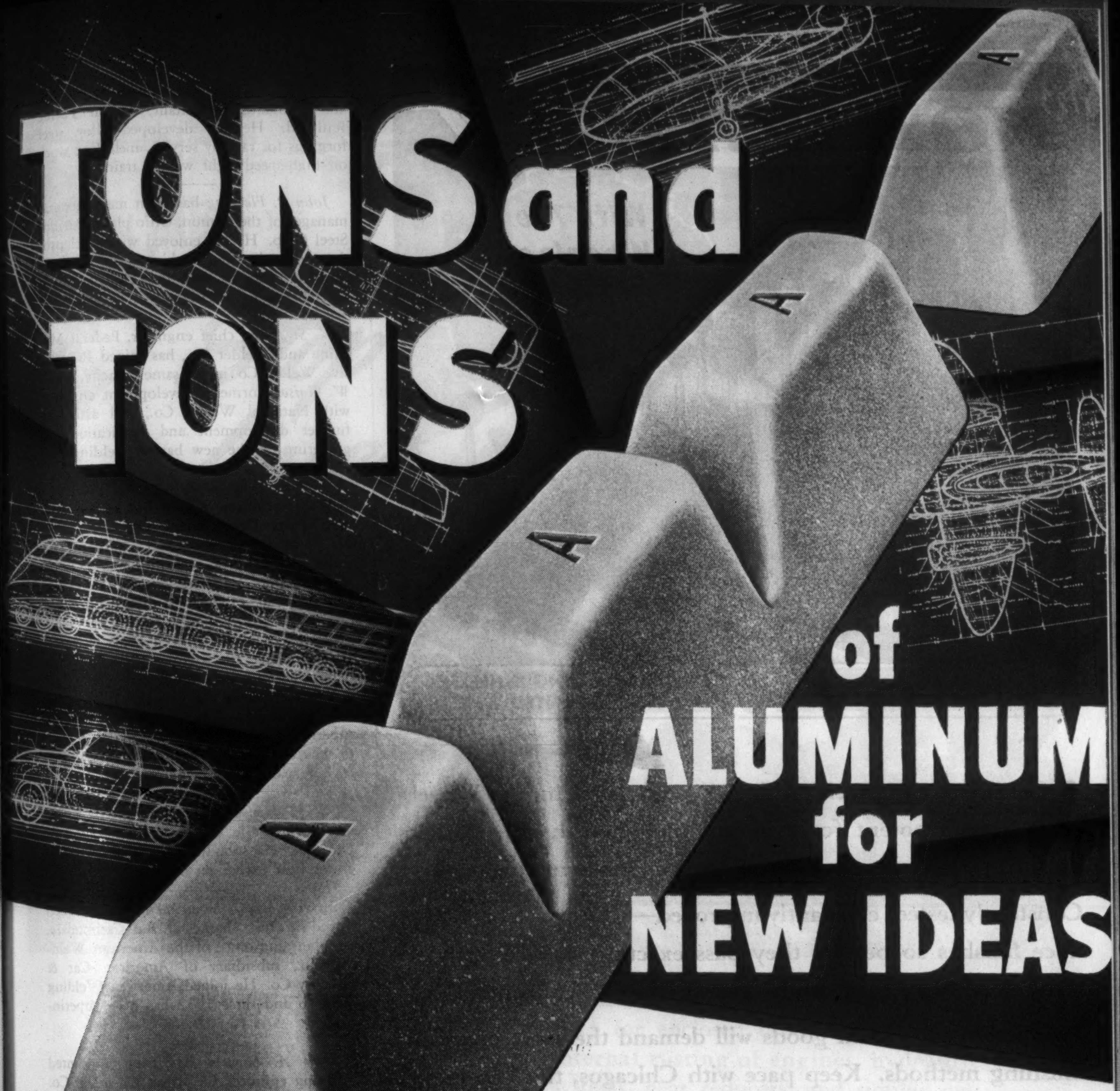
Harry W. Hahn is appointed vice president in charge of engineering and production, H. L. Harvill Mfg. Co., Vernon, Calif., having been a leader in the die casting field on the Pacific Coast for 20 years.

Ernest Greenway Jarvis has become chief metallurgist, Continental Industries, Inc. He has enjoyed wide experience in the alloys field, including that as president of the Niagara Falls Smelting & Refining Corp. He is a lecturer and author.

Paul M. Mueller joins the Blaw-Knox Co. as chief engineer in charge of development. He has invented several precise measuring instruments and new methods for mass production of gaging equipment, as well as much production machinery in the metal field.

Theodore H. Sanderson has been made division superintendent, armor plate div., Gary Works, Carnegie-Illinois Steel Corp. He has had much metallurgical, operation and quality control experience.

John C. Straub, for 13 years with the research laboratories div., General Motors Corp., Detroit, has been appointed research engineer, American Foundry Equipment Co. He is a specialist on fatigue life of automotive gears.



Production of aluminum, built up for use in America's gigantic war machine, is going to find wide application in many of the new products that will later be available for the domestic market.

Advantages of aluminum are manifold—the most important being of course that it combines extreme lightness with great strength.

If your product uses or should use aluminum alloys, this organization is equipped to supply aluminum alloy ingot to your most exacting specifications.

★ BUY WAR BONDS ★

ALUMINUM REFINERS

Division of **BOHN ALUMINUM & BRASS CORPORATION • Detroit 26, Michigan**

General Offices Lafayette Building

MANUFACTURERS OF ALL TYPES AND SHAPES OF CASTING AND DEOXIDIZING ALLOYS

FORWARD
..With The Wheels of Progress..
CHICAGO
GRINDING WHEELS AND MOUNTED WHEELS

• Geared to the precision demands of war, Chicago Wheels have been a potent force in smashing bottlenecks—cutting down rejects—speeding production to an all-time high.

Constantly tested, constantly improved—Chicago Wheels produce finishes so perfect they pass exacting surface analyzer tests, so accurate they can be measured in micro inches.

Production of civilian goods will demand the same precision finishing methods. Keep pace with Chicagos, the Wheels of Progress!

CHICAGO GRINDING WHEELS—Anything up to 3″ in diameter in various grains and bonds, including FV, the sensational new bond with a pedigree.

CHICAGO MOUNTED WHEELS—Shapes and abrasive formulas to take care of every job of internal or external finishing.

TRY ONE FREE! So you'll know what they can do, we will send a test wheel. Tell us material you'd like to finish and size wheel required.

Headquarters for Mounted Wheels and Small Grinding Wheels.

CHICAGO WHEEL & MFG. CO.
Half a Century of Specialization has Established our Reputation as the Small Wheel People of the Abrasive Industry
1101 W. Monroe St., Dept. ME, Chicago 7, Ill.

ME-1
Send Catalog. Interested in ☐ Grinding Wheels
☐ Mounted Wheels. ☐ Send Test Wheel. Size......
Name ....
Address ....

Dr. W. M. Barr has been made research and standards consultant, Union Pacific Railroad. He has developed alloy steel forgings for railway service, including work on high-speed light weight trains.

John P. Fleming has been made general manager of the Canton, Ohio plant, Barium Steel Corp. He has enjoyed wide steel production and metal-working experience in Scotland, Canada and the United States, specializing in forging.

K. Swanson, chief engineer, Federal Machine and Welder Co., has joined Progressive Welder Co. in the same capacity, while *W. Kaiser,* formerly development engineer with National Welder Co., will assist on further development and application engineering on the new battery welding line of Progressive.

Willis Ahlborn Kroop has joined Aircraft Parts Development Corp., Summit, N. J. as industrial design engineer and stylist. He has won recognition as designer of numerous nationally-known industrial and consumer products in diversified fields.

Arthur McNeil has been made technical sales engineer for southern New England of MacDermid, Inc., Waterbury, Conn. He was formerly with the Contract Plating Co. and Bridgeport Thermostat as finishing superintendent. *Arthur Logozzo* is moved to Hartford, covering northern Connecticut and part of Massachusetts.

Albert Hanson has been promoted to vice president in charge of engineering of Drayer & Hanson, Inc., Los Angeles, makers of heat exchange units.

M. A. Cornish, superintendent, has been placed in full charge of the Carbondale, Pa. plant and office of the American Welding Co., subsidiary of American Car & Foundry Co. He joined American Welding in 1916 and since 1932 has been superintendent.

John A. Sargent has been appointed planning engineer for Ansul Chemical Co. and its Dugas Div. His job will be to coordinate the thoughts, ideas and activities of the various Ansul departments.

Porter R. Wray has been appointed manager of the alloy bureau of the metallurgical division, Pittsburgh district, of the Carnegie-Illinois Steel Corp.

Mrs. Harriet Lawson Hall, widow of Everett J. Hall, who from the time of her husband's death in 1931 until 1943 was president of the Metals Disintegrating Co., which he founded, died Oct. 23 at the home of her daughter at New London, N. H. at the age of 68. She had turned over the presidency of the company to her son, Harold E. Hall, in 1943. The company operates four plants, of which three are in New Jersey and one in St. Louis. She was a member of the Engineering Woman's Club of New York and of the Auxiliary of the American Institute of Mining and Metallurgical Engineers.

Stop
RUST
losses with new
WAR-BORN
PREVENTIVES

RUST—a nuisance and a very costly menace in many plants no longer need be tolerated. Laboratory magic has furnished its master.

New Sinclair products, developed to solve tremendous military rust problems, are now available for your plant problem.

Sinclair RUST-O-LENE B for exposed metal surfaces of machinery in operation, in storage, or in transit

- *—provides a firmly-adhering rust proofing film*
- *—prevents rusting of clean surfaces*
- *—halts further rusting of corroded surfaces*
- *—has lubricating qualities*
- *—defies any degree of moisture from mere dampness to heavy rain*
- *—can be readily removed when desired*

Sinclair OPALINE RP (Rust Preventing) OILS for enclosed oil systems, prevent internal rusting of engines, hydraulic systems, gear reducers, and similar machinery intermittently operated, stored, or transported. OPALINE RP also has ample lubricating qualities for temporary use.

Both these remarkable Sinclair rust-preventives have successfully passed the most exacting service tests, and fully meet Government specifications.

Learn how RUST-O-LENE B and OPALINE RP can combat rust for you. Write for brochure giving full details.

SINCLAIR INDUSTRIAL OILS

FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

BRICKSEAL

Assures COMPLETE PROTECTION and LONG LIFE for Refractories

★Highly-glazed monolithic coating prevents cracking and spalling

Brickseal will reduce to a minimum the danger of untimely failure of furnace refractories. This widely-used refractory coating, applied like paint with brush or spray gun, forms a highly-glazed, heat-reflecting, monolithic, protective surface which prevents damage due to cracking, spalling, slagging, air infiltration and sudden temperature variations.

Brickseal should not be confused with ordinary air-set washes which form a plaster-like surface coating. Brickseal consists of high-fusion clays and metals combined in oils. Furnace heat burns the oils and vitrifies the clays and metals, which penetrate deeply into all pores, cracks and joints, binding the bricks into a durable, monolithic wall.

Brickseal cannot crack, blister or peel off due to sudden temperature changes because, at operating temperatures, it becomes semi-plastic, permitting it to expand and contract with the wall. Brickseal also binds old cracked or loosened bricks. Slag may be removed without damage to lining.

You can secure Brickseal protection with very little cost or delay. Write for sample today.

BRICKSEAL
REFRACTORY CO.
1029 CLINTON ST., HOBOKEN, N. J.

Meetings and Expositions

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit, Mich. January 8-12, 1945.

GREAT LAKES POWER CLUB AND CHICAGO LIGHTING INSTITUTE, conference on dialectric and induction heating. Chicago, Ill. January 16-18, 1945.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting. New York, N. Y. January 17-19, 1945.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, annual meeting. Boston, Mass. January 22-24, 1945.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, national technical meeting. New York, N. Y. January 22-26, 1945.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York, N. Y. January 30-February 1, 1945.

AUTOMOTIVE ELECTRIC ASSOCIATION. Chicago, Ill. February 5-12, 1945.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. New York, N. Y. February 18-22, 1945.

AMERICAN SOCIETY FOR TESTING MATERIALS, spring meeting. Pittsburgh, Pa. February 26-March 2, 1945.

Briefs on Associations, Promotions and Education

Provision within the scope of the curriculum for an engineering degree of stronger courses designed to add elements of a liberal education was advocated before the American Society of Mechanical Engineers by Dean Clement J. Freund, University of Detroit. To achieve liberalizing aims at the University of Detroit, the faculty has made 200 course revisions, including the introduction of new courses.

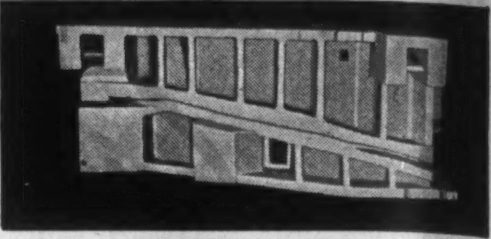
At the 1944 annual meeting of the Engineer's Council for Professional Development, E. S. Lee, engineer, general engineering laboratory, General Electric Co., was re-elected chairman. The Council is a conference of seven engineering organizations formed to enhance the professional status of engineers through cooperative effort.

"Tornado in Box" is a 16-mm. film, for sound projectors only, describing the gas turbine and released by Allis-Chalmers Mfg. Co., Milwaukee. It is being loaned free to industrial and engineering groups.

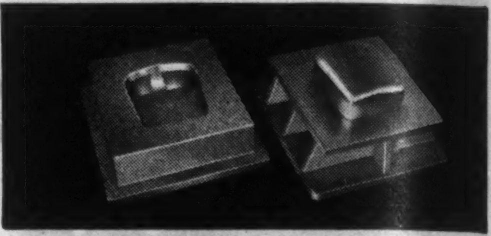
A minimum production of 200,000 tons of synthetic rubber annually in peace time for national security reasons was advocated by John L. Collyer, president, B. F. Goodrich Co., at the Fall Conference, Society of the Plastics Industry. He said that 1,000,000 tons would be needed in the first year after

SCORES OF OUR LEADING INDUSTRIES USE STRENES

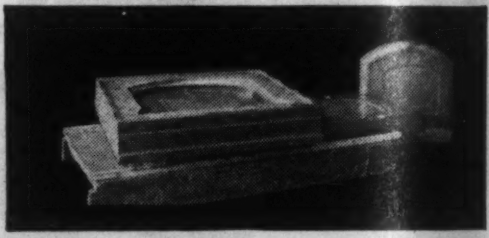
Body Top Die



Radiator Shell Die



Grave Vault Die



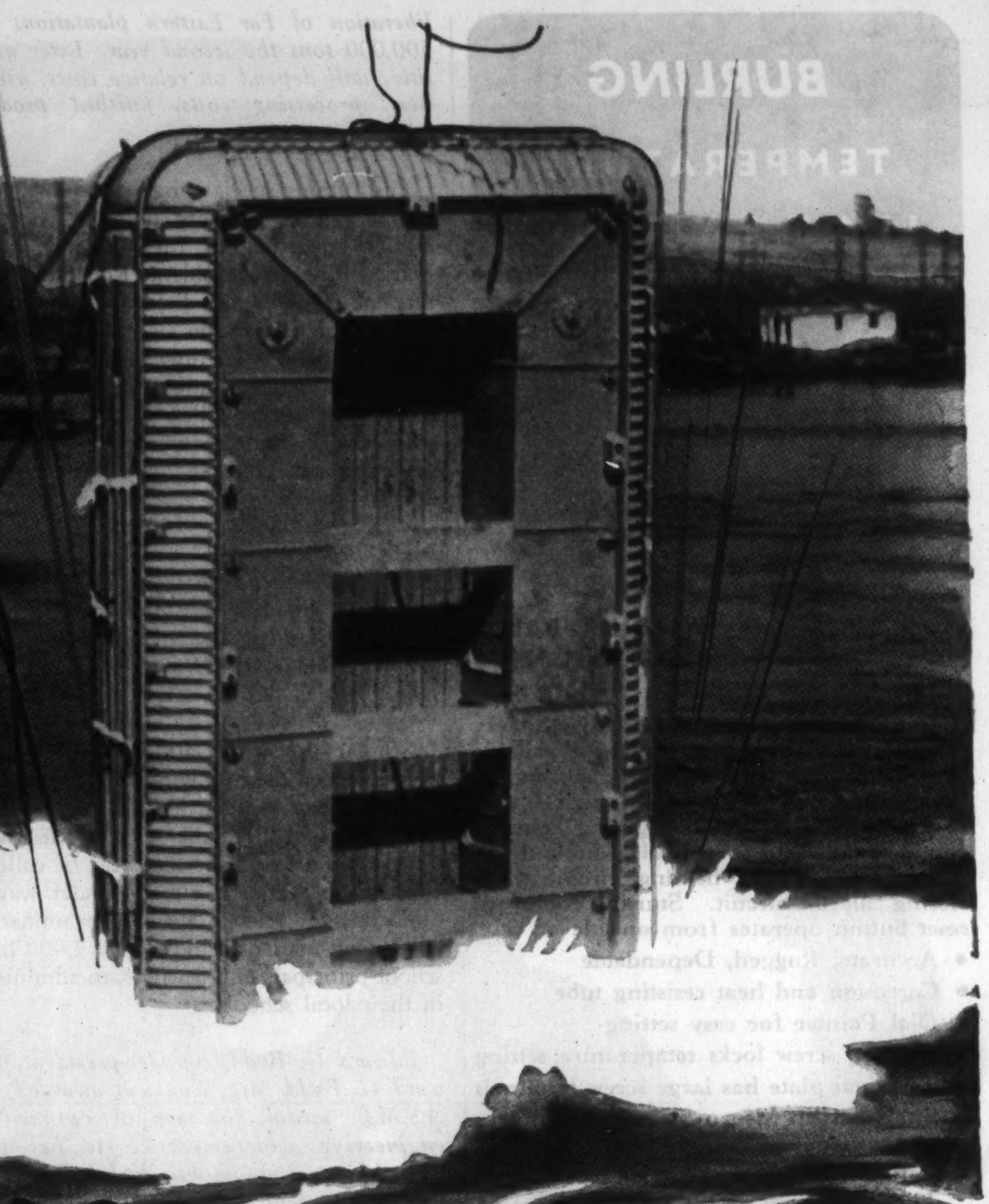
Because Strenes Metal can be cast to shape—because it usually saves about one-half on machining time—because its self-lubricating properties make for long runs and infrequent re-dressings—

Because of these and still other advantages, most of our automotive firms, stove manufacturers, refrigerator builders and many more specify Strenes regularly for drawing and forming dies.

Get the facts. They should convince you. Write.

The Advance Foundry Co.
100 PARNELL ST.,
DAYTON 3, OHIO

Strenes METAL



EASY-FLO ended a bottle-neck in building all-metal life rafts

EASY-FLO WASHER

Here's how the drain flange brazing is done. Flange and plate surface around the hole are cleaned and fluxed. Flange is placed in hole, with a washer of .003" EASY-FLO between. Assembly is placed in coil of induction heating unit. Pressure is exerted on flange during heating with the device shown. With this simple production set-up a joint is completed in 31 seconds that equals a single piece in strength and leak-tightness.

IN the production of these Weber-built all-metal life rafts for cargo ships and tankers, 48 manganese bronze drain flanges are joined to 1020 cold rolled steel plates.

At first this was done by bronze welding which took from 7 to 12 minutes per flange. Brazing with EASY-FLO and induction heating broke this bottleneck. The production set-up described at the left was worked out. Now, one man and a woman helper braze these flanges in 31 seconds each—the fastest operation in the whole assembly.

The strength and leak-tightness of these fast-brazed EASY-FLO joints are amply proved by government-prescribed water column and air pressure tests of the completed rafts and by drop-off tests like the one pictured above in which the raft smashes into the water from a height of 45 feet.

Because EASY-FLO makes strong, leak-tight joints in ferrous and non-ferrous metals with exceptional speed and reliability, it is extensively used throughout industry on a wide variety of metal joining operations. This low-temperature, free-flowing silver brazing alloy is a proven production-booster and money-saver. That's why it should have a place in your metal joining operations—present and future. Get full EASY-FLO details in Bulletin 12-A. Write for your copy today.

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BURLING
TEMPERATURE
LIMIT SWITCHES

USE NO LIQUIDS . . . NO GASES

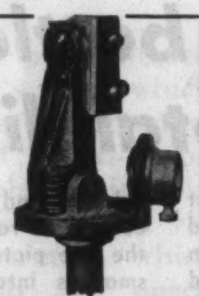
MODEL H
WITH MANUAL
RESET BUTTON

Improved High Temperature Safety Switch with Manual Reset Button. Available with switch normally closed for cutting off heat, stopping fan, closing valve—with switch normally open for lighting lamp or ringing bell—with single pole double throw switch . . . breaks heating circuit while closing alarm circuit. Sturdy, foolproof reset button operates from outside of case.

- Accurate, Rugged, Dependable
- Corrosion and heat resisting tube
- Dial Pointer for easy setting
- Locking screw locks temperature setting
- Terminal plate has large screw terminals
- Snap-action Micro-Switch eliminates contact troubles
- Range 0-1400°F. Adjustable range 200-300°F
- Dimensions—5⅛" x 1¾" x 3"

MODEL V-I

For lower temperature range from 0-300°F. Available for minimum of —100° to maximum of 600°F. Usual adjustable range 50-150°, operating differential may be as small as ±¼ or as large as ±5°. Adjustable by screw and dial inside case. (Sizes 2¾" diameter × 4¼" high)



MODEL D
Adjustable range 200-500°F. Temperature range 0-1400°F. For use where temperature must be changed to suit operating conditions. Turn outside knob to change temperature setting. (Sizes 5½ x 2¾ x 2¾").

Instruments also Built to Specifications

Send for Informative Manual

BURLING INSTRUMENT CO.
Springfield Ave. at Livingston St.
Newark, N. J.

liberation of Far Eastern plantations and 500,000 tons the second year. Later quantities will depend on relative costs, usefulness, processing costs, finished products performance, etc.

Institutions specializing in technical education will overshadow all other forms of higher education in the post-war, stated Mark Ellingson, president, Rochester Institute of Technology, before the A.S.M.E. Since their education is functional and practical, they will draw many returning veterans. They do not require so long a training period as colleges and engineering schools. They individualize programs and make adjustments that universities will not do.

A "Products of Tomorrow" Exposition will be held at the Chicago Coliseum about March 1. Managers are ambitious to make it another Leipzig Fair. The general manager is Marcus W. Hinson, Chicago Coliseum, 1513 S. Wabash Ave., Chicago.

Scholarships worth almost $82,500 have been awarded the 300 winners of the second annual Science Talent Search, conducted by Westinghouse, the money to help the young hopefuls through their first year of college. The fourth search is already under way, a difficult 2-hr. science aptitude examination now being mailed to more than 3,000 high school principals and teachers, to administer in their local schools.

Edward G. Budd, founder-president, Edward G. Budd Mfg. Co., was awarded the A.S.M.E. medal "because of outstanding engineering achievements." He has pioneered in steel automobile bodies, Shotweld processes of fabricating stainless steel, light weight railroad passenger trains, and intricate dies for forming sheet metal by deep drawing.

The United States may find in Russia's post-war needs a stopgap for its own post-war employment program, stated Admiral William H. Standley, former ambassador to Russia, before the A.S.M.E. Russia needs consumer goods of all descriptions and much machinery for new developments and replacements. However, we cannot expect to make much profit out of exports to Russia as the Soviets are notoriously against profits. These statements were made before the Society of the Plastics Industry.

Continuing its program of formulating training standards for welding operators, the American Welding Society has published "Part B-1—Oxy-Acetylene Welding of Steel—Aircraft" of the "Code of Minimum Requirements for Instruction of Welding Operators." One primary and one advanced course have been established. Copies may be secured at a nominal cost from the society at 33 W. 39th St., New York 18.

Metal-cutting industries, using tools tipped with cemented carbides, have often found it advantageous to use solid carbide blades, W. L. Kennicott, Kennametals, Inc., told the A.S.M.E. Break strengths of the carbides have doubled and carbide prices are 3½¢ per unit on large standard blanks as against 45¢ in 1940.

FOSECO

Products that make
BETTER castings!

TODAY . . all specifications stress quality. Examiners are quick to reject inferior castings.

TODAY . . more and more foundries are using more and more "Foseco" products.

THERE'S A REASON!

ALUMINUM DE-GASER
for degassing aluminum alloys

- Removes gases
- Eliminates pinholes, pitmarks.
- Removes dirt, slag and solid impurities.
- Removes aluminum oxide.
- Improves physical properties, higher tensile, greater elongation.

COVERAL
scientific "blanket" for melting aluminum

- Stops oxidation.
- Eliminates aluminum oxide.
- Cleans dirt, etc. from metal.
- Creates no fumes.
- Increases fluidity.
- Not hygroscopic, so no accidents.
- Inexpensive to use.
- Saves metal.

FIRIT
Longer life for Ladles, Furnace Linings, Crucibles, Stirrers, etc.

- Prevents "Iron Pick-up" by aluminum when melting in iron pots.

ALBRAL
Removes Oxides: Higher Physical Properties
for
- Aluminum Bronze
- Manganese Bronze
- Sicilon Bronze
- Aluminum Brasses, etc..

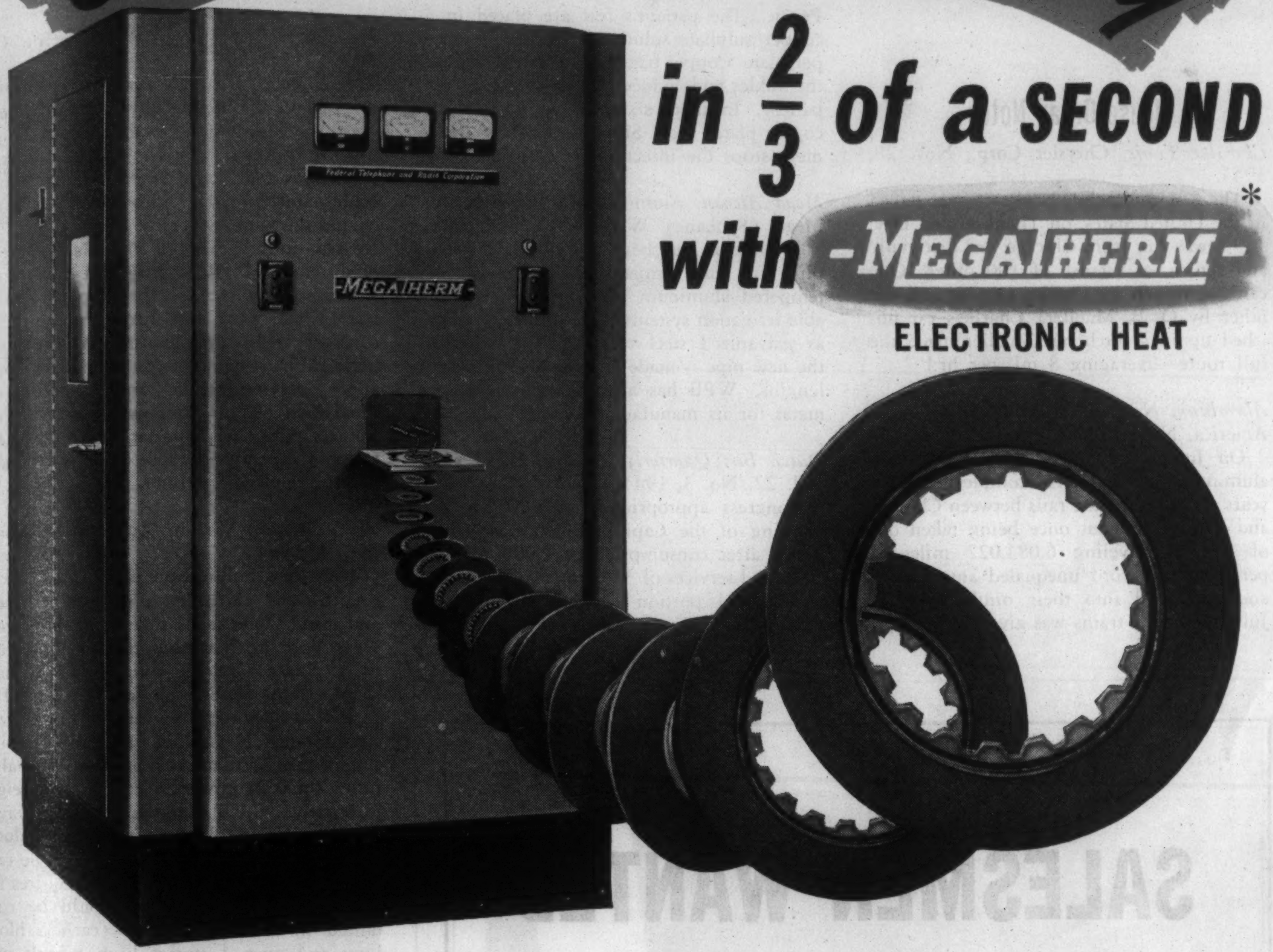
THESE and other "Foseco" products will solve your casting problems quickly, efficiently. For detailed information, write stating nature of problem and alloy you are casting.

FOUNDRY SERVICES, INC.
280 Madison Avenue
New York, N. Y.

Exact Contour Hardening

in $\frac{2}{3}$ of a SECOND with -MEGATHERM-*

ELECTRONIC HEAT



Here's another difficult hardening job, done simply and quickly with Megatherm.

Exact contour hardening of the inner gear of these supercharger clutch discs was done in less than ⅔ of a second each.

These gears were hardened to a depth of .050″, with the hardening closely following the tooth and root contour of the gear surface, without affecting the strength or ductility of the remaining metal. The unretouched photograph above tells the story.

To do this contour hardening a jig was built to support the disc so that its inner surface surrounded a two-turn induction coil, directly connected to the output terminals of the 25 kw Megatherm.

The Megatherm automatic timer limits the heat period to exactly ⅔ of a second, then operates a solenoid which trips the disc into an oil-quench bath.

Here is another example of Megatherm's adaptability to many hardening problems involving irregular and "hard-to-get-at" surfaces.

If you have a surface hardening problem . . . whether for wartime or peacetime application . . . consult Federal's Megatherm engineers for the answer or write for complete data.

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The American Institute of Mining & Metallurgical Engineers has elected as president for 1945 Harvey Seeley Mudd, president and managing director, Cyprus Mines Corp., Los Angeles. Two vice presidents elected are: Donald H. McLaughlin, vice president and general manager, Cerro de Pasco Copper Corp., New York; and Leo F. Reinartz, manager, Middletown Div., American Rolling Mill Co., Middletown, Ohio.

House Organ Notes

Chrysler Tonic, Chrysler Corp., Nov. 28, 1944.

The first automobile road race ever staged in the United States, on Thanksgiving Day, 1895, was run from Chicago to Libertyville and return, a distance of 100 miles. One car was driven by Charles Duryea and the other by O. B. Mueller. Charlie's car finished up in a ditch but Mueller made the full route—averaging 8 mi. per hr.!

Aluminum News-Letter, Aluminum Co. of America, Nov. 1944.

On June 18 last the "City of Denver" aluminum streamliners completed eight years of pounding the rails between Chicago and Denver without once being taken out of service, traveling 6,084,022 miles—a performance record unequaled anywhere—and continued into their ninth year. In July one of the trains was given a thorough reconditioning. Average running time up to Pearl Harbor was 65.5 miles per hr., including eight station stops, with somewhat slower since because of war conservation.

Ohmite News, Ohmite Mfg. Co., November 1944.

An unusual method of combating that stubborn fungus infection, athlete's foot, has recently proved successful in the South Pacific. The patient's feet are placed in a copper sulphate solution containing a copper plate. Copper bands are fastened around the ankles and connected to a six-v. storage battery. In about six min. the patient has copper-plated feet! Six or seven days' treatment stops the infection.

Mead Alcoan, Aluminum Co. of America, Mead (Spokane) Wash. Nov. 30, 1944.

Production has begun in Portland by a pipe and tank company of a new alloyed, tempered aluminum pipe, suited for portable irrigation systems. One-fourth as heavy as galvanized steel tubing, 20-ft. lengths, the new pipe is made and handled in 40-ft. lengths. WPB has allocated the necessary metal for its manufacture.

Dutch Boy Quarterly, National Lead Co., Vol. 22, No. 3, 1944.

Congress appropriated $40,000 for repainting of the Capitol, a job now completed after consumption of 2,000 gal. of paint and services of 35 painters. The dome and central portion of the building, of sandstone, required coating of 58,000 sq. yd. North and South wings, of marble, needed no paint. The dome is not painted white, but a light gray, causing it to appear more luminous when floodlighted in peace time. The dome contains nearly 9,000,000 lb. of cast iron, requiring the services of experienced structural steel painters. The bronze figure of Freedom, atop the dome, merely received a bath of linseed oil. Previous repainting of the Capitol was in 1939 at a cost of $30,000.

Instrumentation, Brown Instrument Co., Sept.-Oct. 1944.

Plexiglass sections, cockpit enclosures, etc. on aircraft are by now familiar. Plexiglass processing starts with a liquid as free flowing as water. This is poured into special molds and heated when individual molecules link together into chains. As the chains grow the viscosity of the liquid increases until the solid Plexiglass sheet is finally formed. Recording and control instruments are essential, for proper polymerization can vary but little and must be constant within predetermined levels and periods. Dust or other contamination would affect polymerization and discolor the Plexiglass. The monomer must be extremely pure. Wide variations in polymerization temperatures cause bubbles or other defects, rendering it unfit.

Trade Winds, Wright Aeronautical Corp., Oct. 9, 1944.

Here is a publication where art work is superb—and altogether pleasing to the eye and mind. One reads that on a flight from New York to Washington the spark plugs in a single Cyclone cylinder flash more than 81,000 times; the four Cyclone 18's in a B-29 have more power than 88 average automobiles; a Cyclone 18's oil-pumping system can circulate at more than 43 gal. a min.; equal in power to a fair-sized freight locomotive, the 2,000-h.p. Cyclone weighs no more than the locomotive's wheels alone, takes up less space than there is in the cab; in less than 3 hr. a Cyclone 18 requires for combustion more air than could be contained in a K-type blimp (each a block long and over 4 stories high); built into the combat cylinders of a Cyclone 14 is a cooling area of 580 sq. ft., or more than the area of a pair of bowling alleys.

The Aluminator, Lafayette Works, Aluminum Co. of America, Nov. 24, 1944.

Twenty-six men from the Lafayette plant participated in a novel musical stunt at Purdue University under the direction of the music director, Al Stewart. Al made a bet that he could take a small group of men who had never sung together and, within a half hour, teach them a song and have them sing it in four-part harmony. Much to everyone's surprise, 20 min. was all that was needed for a very creditable performance. The idea was to prove that industrial workers can sing as well as anyone else after some training. It all goes with building up morale of a plant.

Non-Ferrous Forgings Digest, Brass Forging Assn., Vol. 1, No. 1, Oct. 1944.

This new publication announces that it will feature non-ferrous forgings and their many uses, as well as technical data on their characteristics. The headquarters is at 420 Lexington Ave., New York 17.

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By an established industrial publisher; men who are familiar with operations and equipment used in either chemical processing or metal working industries or both. Sales, sales engineering or advertising experience with manufacturers serving either of these fields would be helpful. Work would be on a sound going project with opportunity for increased earnings on a salary and bonus plan. Write, giving full details.

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